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Manual of Instructions

990 SERIES
Magnet Treaters

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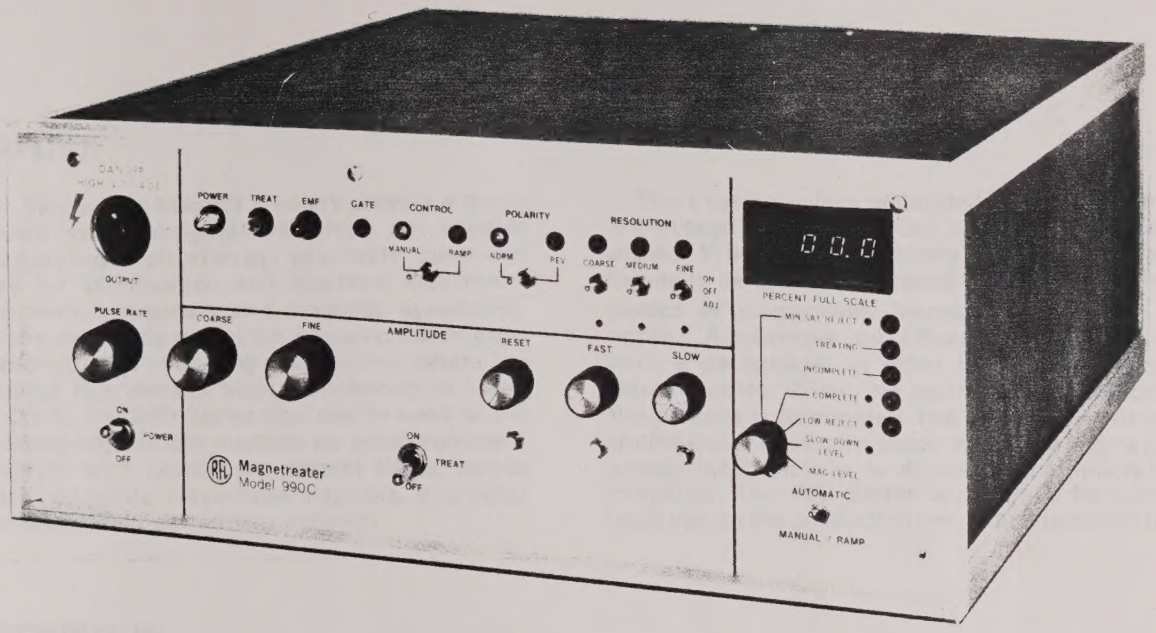

Figure 1. Typical 990 Series Magnetreater®

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INTRODUCTION

PURPOSE

The 990 Series Magnet Treaters provide a group of pulse-type demagnetizers which are capable of supplying high-energy, precisely controlled pulses for stabilization and flux-level adjustment of permanent magnets and magnetic assemblies. They are especially useful for magnetic stabilization of direct-current indicating instruments where the controlled flux density must be resolved to better than 0.1%. The 990 Series also can be used as the calibration-adjustment medium for accelerometers, dc motors with permanent-magnet fields, torque motors, traveling-wave-tube magnets, and other assemblies using permanent magnets.

The treating pulses qenerated by the 990 Series are passed through a fixture in which a magnet is placed. While the flux density of the magnet continues to be above the desired level, demagnetizing pulses of successively increasing magnitude are applied. A measurement of flux density may be made, with a gaussmeter or other indicator, after each treating pulse. When the desired level is indicated, the process is terminated. The process may be controlled either manually, automatically through a local analog-feedback loop, or digitally and remotely by a computer. The 990 Series is designed for continuous use on the production line, or as a research tool.

DESCRIPTION

Series 990 Magnet Treaters use a high-voltage power supply, a bank of energy-storage capacitors, connections for a treating fixture, a triac used as the discharge-control device, an interlock circuit, and several types of control circuits. All are contained in a cabinet, shown in Figure 1, which may be mounted either on a bench or in a relay rack for bench top use. Rack mounting requires the addition of RFL 48587-3 Rack Mount Kit.

Pulse-amplitude regulation is continuous, so that the amplitude of demagnetizing pulses is unaffected by line-voltage fluctuations. Average line demand is small due to the stored-energy technique used. The equipment may be operated from any convenient 115- or 230-Vac source provided with a proper ground.

Demagnetizing power applied to the treating fixture is continuously variable from 20 to 80,000 VA. In some cases power levels as great as 140,000 VA are obtainable. When needed, additional capacitance can be added to the energy-storage bank in the form of a booster unit. Connections are made via a terminal block inside the instrument.

Amplitude of the output pulses is set by the voltage on the energy-storage capacitors at the moment when the triac connects the treating coil to the capacitors. In manual operation, this "firing level" is set by adjustment of the COARSE and FINE amplitude controls. With dual-slope control, either manual or automatic, the firing level is set by an internally generated, negative-going reference signal. Under digital control, the firing level may be set by either the dual-slope control, directly or digitally by the controller itself.

Model Designations

Three forms of the 990 Series are available, with differences as described in the following:

Model 990A Magnetreater® , the front panel of which is shown in Figure 2, is designed for either manual or bus-remote control of the treating process.

In the manual mode, the operator slowly increases the magnitude of the demagnetizing pulse, using the front-panel controls, while visually monitoring the approach to the desired level of flux density, using whatever level-monitoring device is provided. In bus-remote control, the process is completely controlled by a computer.

Model 990B, shown in Figure 3, provides for either manual, dual-slope, or bus-remote operation in which the time rate of approach of the demagnetizing pulse is under control of a ramp signal. The slope of the ramp signal may be set either by front-panel switches and level controls, or a computer.

Model 990C, shown in Figure 4, provides manual, dual-slope (ramp) control combined with automatic operation through a local, analog-feedback loop or automatic module.

The 990 Series is of modular construction, which permits simple assembly of the three basic models for the types of operation required. Table 1 lists all models and modules, and describes which is required for each kind of control.

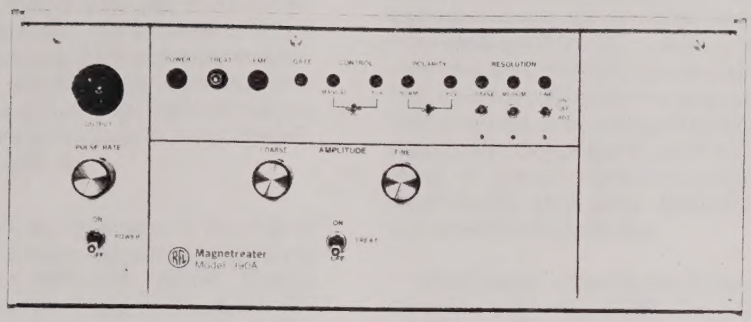


Figure 2. Front panel of Model 990A

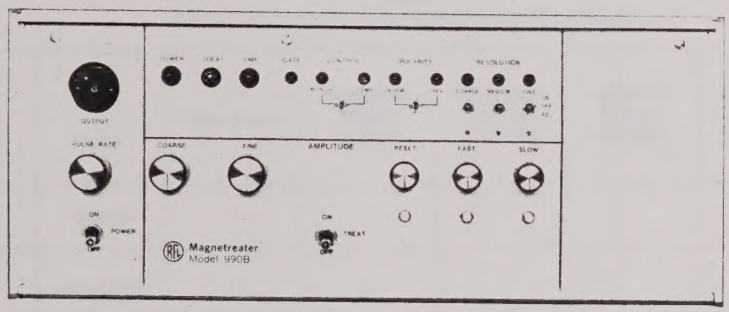


Figure 3. Front panel of Model 990B

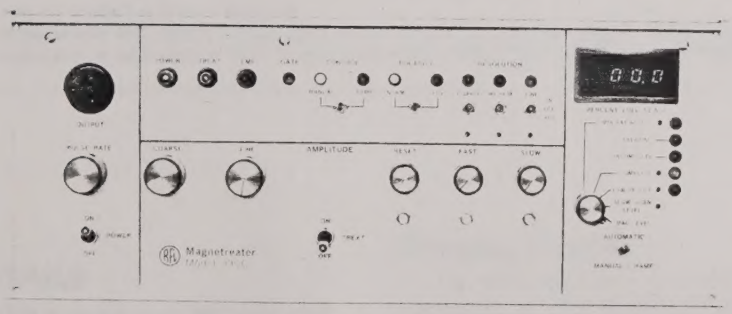


Figure 4. Front panel of Model 990C

Operation Through IEEE-488 Bus

Models 990A and 990B can be controlled through the IEEE-488 Bus with the addition of a bus controller and an interconnecting board with coupler. The coupler used is the Model 4823, manufactured by ICS Electronics Corporation. The interconnecting board and the coupler are combined to form the RFL HB-95680 IEEE-488 Interface.

With the addition of this assembly to the Model 990A or 990B, the equipment becomes the Model 990A or 990B with the IEEE-488 Option. Output signals conform to the standards set for the IEEE-488 Bus, and they are contained in a 24-pin output connector which is also standardized. This is mounted on the rear panel of the Model 990A or 990B.

The Model 4823 Coupler is a general-purpose card used to connect devices to the IEEE-488 Bus. It comes in a standard hardware configuration that is firmware-configured, using a programmable read-only memory (PROM), according to RFL's application. The firmware defines the data polarity (positive true), status levels, and handshake-line polarity. While the assignment of ports is determined by the programming of the UV-light-eraseable PROM, the PROM used in this application depends upon standard, off-the-shelf programming.

The interconnecting card includes the Model 4823 Coupler, eight input lines for address and control, 56 parallel bi-directional I/O lines, and 11 status and data-handshake lines. The PROM used with the 990 Series assigns 28 parallel input lines and 28 parallel output lines.

Table 1
MODEL DESIGNATIONS AND MODULE COMPLEMENTS (1)

Model	Method of Operation	Method of Control	Main Frame	Comparator Module HB-96510	Dual-Slope Module HB-96520	Automatic Module HB-95650	IEEE-488 Interface Module HB-95680	D-to-A Ref Gen Module HB-95695
990A	Manual	Manual	X	X	–	–	–	–
990A	Bus	Auto-Digital (3)	X	X	–	–	X	X
990B	Manual	Manual (2) Dual-Slope	X	X	X	–	–	–
990B	Bus	Digital (3) Dual-Slope	X	X	X	–	X	–
990C	Auto	Auto (2) Dual-Slope	X	X	X	X	–	–

NOTES: (1) X indicates the module or item is required.
(2) Requires gaussmeter with analog output, such as RFL Model 912, or other analog feedback signal.
(3) Requires gaussmeter with parallel BCD output, such as RFL Model 912, or other digital feedback signal.

FUNCTIONAL DETAILS

Figure 5 outlines the energy-conversion and control functions of the 990 Series. Sections without asterisks show the functions used for either manual or automatic operation under local control. Sections of the block diagram with asterisks, are required for bus-remote operation using a controller operating over an IEEE-488 Bus.

Treating Circuits

The nine blocks at the right of Figure 5 show the elements of the treating function. Input power is controlled to improve resolution of the end-point of the process. Polarity of the treating pulse is reversible so that magnets saturated in either magnetic polarity can be treated. The energy stored in the energy-storage bank is discharged into the treating fixture where the product to be treated has been placed.

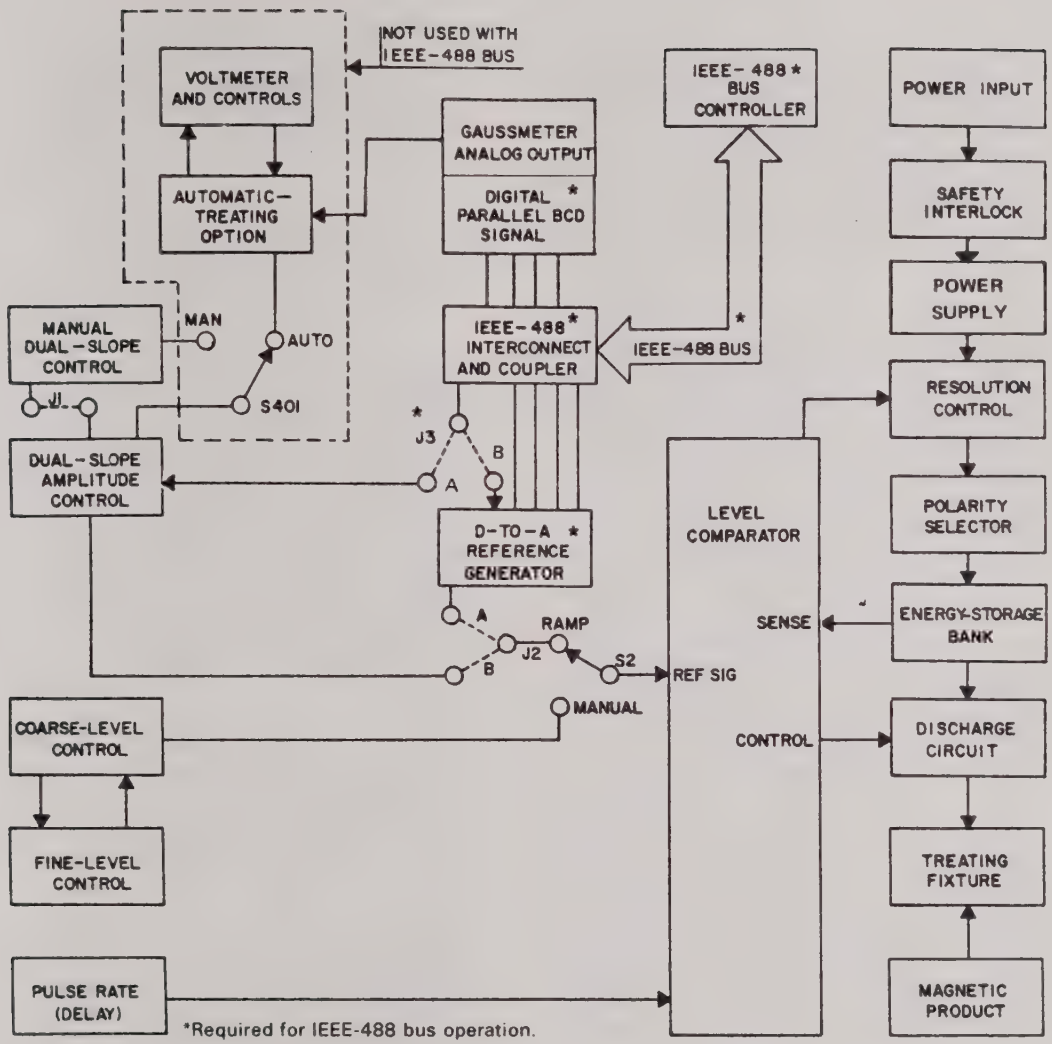


Figure 5. Block diagram of circuits, 990 Series

Level Comparator

The level comparator, shown near the lower center of the block diagram, continuously compares the voltage level on the energy-storage bank against the target level established by the control circuits at the left. When the voltage level of the storage bank reaches the target level, the output-control circuit of the level comparator fires the discharge circuit and dumps the stored energy into the treating fixture.

Manual Operation

Manual control of the treating process can be effected with any model of the series. The Model 990A, is the most basic unit. Switch S2 is set at MANUAL. The COARSE and FINE treat-level controls and the PULSE RATE control are set as desired. When the Treat ON/OFF switch is in the ON position the treating pulses repeat automatically. Then, the operator raises the treating level manually until the flux-density monitor used, such as a gaussmeter, indicates the desired level has been reached. Treating action will stop when the Treat ON/OFF switch is placed in the OFF position. Resolution controls are operative in this method, as in all others, and may be used to suit a given application.

Dual-Slope Operation

The Model 990B includes the addition of a dual-slope control card and the necessary front-panel controls. The dual-slope circuit provides a ramp-type reference voltage to the level comparator in a format that is designed to minimize the time required for each treating cycle.

(a) The amplitude of the first treating pulse is controlled by the setting of the RESET control. This sets the initial condition of an integrator used to develop the ramp-shaped reference signal. The level may be set high, to permit a quick approach to the end-point.

(b) The FAST control adjusts the slope of the reference voltage relatively steep, so that incremental increases in the treating pulses following the initial step, are large enough to continue to approach the end-point quickly.

(c) Finally, the SLOW control reduces the slope of the reference voltage so that incremental increases in reference voltage are smaller. Thus, resolution of the end-point level is maximized.

For dual-slope control of the reference voltage to the level comparator, S2 is set to RAMP: on the block diagram Jumpers J1 and J2B would be in place. These jumpers do not exist in fact, but are a fiction that helps make the block diagram more understandable. J1 explains the fact that with no automatic module installed, the front-panel controls must be connected directly to the dual-slope circuit card. Similarly, J2 and J3 are used to indicate that either the dual-slope circuit card or the D-to-A reference generator will occupy the same circuit-card slot, because only one reference signal may be delivered to the level comparator.

Automatic Operation

To provide completely automatic, closed-loop operation, the Model 990C includes a digital indicating meter and a circuit card identified as an automatic module. These appear at the top-left corner of Figure 5.

Using the analog output signal from the gaussmeter, which monitors flux density in a magnetic assembly, the automatic module tests for adequate level of saturation before treatment. It then monitors the flux density after each treating pulse and controls the dual-slope module. When the module identifies the end point, the process stops. Finally, it tests to determine whether the final flux-density is within acceptable limits.

Flux-density levels at critical points in the process are set with screwdriver-adjust controls on the front panel by using the indicating voltmeter to establish each critical level.

IEEE-488 Bus Control

To operate the Model 990A and 990B from an IEEE-488 Bus controller, a gaussmeter with parallel BCD output such as the RFL Model 912 is required, and an HB-95680 IEEE-488 Interface must be added. This will permit remote control through the bus using the dual slope method of treating-pulse-amplitude control. In the Model 990B a connection corresponding to Jumper 3A, Figure 5, is made.

The Model 990A requires that the level of each treating pulse be set by the bus controller. The reference voltage required by the level comparator must be obtained from a digital-to-analog converter which occupies the card slot vacated by the dual-slope board. This circuit card accepts the target level for each pulse, received in digital form from the bus controller, and converts it to an analog signal for use by the level comparator. In this method, a connection corresponding to Jumper J3B is used.

APPLICATION

Treating, or stabilization, of a magnetic material or assembly is accomplished by introducing repetitive, damped oscillatory pulses into a treating coil within which the magnet or assembly has been placed. No mechanical motion of coil or assembly is necessary. The damped characteristic of the treating pulse, whose magnitude is slowly increased, gradually reduces the flux density of the magnet to the desired level. The end-point of the process is determined either by the operator or automatically.

At the lowest level of operation, the easiest magnetic domains are scrambled, and all harder domains remain unchanged. As the treating level is increased, harder and harder domains are scrambled, with a corresponding reduction of flux density. Each succeeding half-wave of the damped pulse train passing through the treating fixture peaks at a smaller absolute value and in a direction opposite from that of the peak just preceding. For a given treating pulse, the maximum number of domains is switched on by the first half-wave. But since the second half-wave is smaller and of opposite polarity, the hardest domains out of those switched by the first half-wave remain as they were. All others switch back. This continues until all easy domains below the treating level are scrambled.

The frequency of each demagnetizing pulse is a function of the capacitance and inductance of the circuit. The Series 990 uses a capacitance of 100 μF in its energy-storage bank. With most treating coils, the frequency of the damped, oscillatory pulse is between 100 and 200 Hz. Additional energy-storage capacitors can be added, externally, if needed. Consult factory before adding capacitors.

Materials of the Tungsten, Chromium, and Alnico groups, as well as Lodex and many configurations of Barium-Ferrite material may be treated to the desired level of flux density. In some cases, the Model 990 may be used for total demagnetization.

The wide range of plug-in modules available, as shown in Table 1, permits versatility in planning a system and provides for programmed, automatic operation when needed. When the IEEE-488 Interface card is used, great versatility of programs is available. Programs can be arranged to treat successive magnets to different flux densities for special

applications, such as sets of magnets for use with traveling-wave tubes.

Treating Coils

Table 2 shows the inside dimensions of the most widely used treating coils. Many other sizes are available. Data thereon may be requested. Universal fixtures for many types of panel meters are available and are listed in the current price list.

The volume, or dynamic level of treating flux available depends primarily on the cross-sectional area of the treating coil. A coil with a smaller window area will provide a higher flux density than will a coil with larger area (when the energy delivered to both coils is the same). The Series 990 is designed primarily for stabilizing magnets such as Alnico, Cobalt, and Tungsten. It will, however, treat small volumes of materials of higher coercive force, such as Cobalt-Platinum and Barium-Ferrite. In these cases, a coil with a small internal diameter is required to provide the flux concentration necessary for treating these materials.

Table 2
STANDARD COIL DIMENSIONS

Part No.	Rectangular (Inside)	Round (Inside)
HC-7010-1	2½" x 4½"	
HC-7010-2	3" x 6"	
HC-7010-3	4" x 8"	
HC-7010-16		3½" diam.
HC-7010-22		1½" diam.

The type of treating coil required will depend also on the shape of the structure to be treated. It should be noted that a rectangular coil has the least uniform field. A high concentration of flux will be found in the corners. Circular coils are most uniform.

When treating a large number of magnets in production, it is advisable to use a jig to hold each magnet in the same physical location within the coil. This will ensure that each magnet receives nearly identical demagnetizing forces while using just one setting of the amplitude controls. The demagnetizing force in any coil will vary with the location of the magnet with respect to the center of the coil.

CAUTION

Do not use homemade treating fixtures. Treating coils must be designed to meet the impedance requirements of the Magnetreater® and to safely withstand the high voltage applied.

Similarly, replace treating coils that are worn or abraded from extensive use.

Design Service

RFL maintains an Applications-Engineering section to provide design service geared to the requirements of each individual user. This includes design of charging, treating, and measuring fixtures used in complete systems. Recommendations are made on the basis of economy and reliability. There is no charge for this service.

SPECIFICATIONS

Demagnetizing Power

Variable from less than 20 VA to 80,000 VA. In some cases, levels as great as 140,000 VA are obtainable.

Pulse Rate

Adjustable between 50 and 200 pulses-per-minute.

Resolution

0.1% maximum

Energy Storage Capacity

18 watt-seconds

IEEE-488 Bus Interface (Models 990A and B only)

Talk and Listen Mode

Parallel BCD output signals from a gaussmeter enter talk ports on the bus-coupler card to be processed. Relay commands and parallel BCD data leave the coupler through listen ports. All input and output ports are latched. The outputs (device listen) control relays, command signals, or the parallel BCD input to a digital-to-analog reference-signal generator.

Address Mode

This mode allows connection to an IEEE-488 compatible bus controller. The address is selected with a switch array mounted on the rear panel.

Logic Levels

When fitted with the Model HB-95680 Interconnecting Board, the equipment meets all requirements of the IEEE Std. 488-1978 specification.

Output Connector

24 pin, IEEE-488 standard connector.

Installation

This interface mounts within the cabinet of the main frame.

Accessories

An IEEE-488 Interface cable, 1 meter (3.3 ft) long, is available.

Environment

Operate: 0 to +40°C, 20 to 80% relative humidity.
Storage: -20 to +85°C.

Primary Power

115/230 V, 50/60 Hz.
Line demand: 3 amperes (maximum surge during power-on).

Dimensions

Bench Cabinet: 19" wide, 7" high, 15½" deep (483 x 178 x 394 mm).
Relay-Rack Cabinet: 19" wide, 7" high, 15½" deep (483 x 178 x 394 mm).

Weight

42 lbs (19 kg).

INSTALLATION AND OPERATION

UNPACKING THE EQUIPMENT

For shipment, the equipment is packed in a sturdy commercial carton. Accessory items often are packed in another carton. Upon receipt, the shipment should be examined for both apparent and concealed damage. Damage should be reported to the carrier and to RFL. Cartons and packing material should be retained for examination by the carriers representatives.

When unpacking, examine all packing materials carefully to ensure that items of value are not discarded. A check of electrical performance should be made as soon as feasible to confirm operation.

CAUTION

To avoid exposure to hazardous voltages, observe procedures given on Pages iii and iv.

ELECTRICAL CONNECTIONS

Before applying power to the Model 990, check the marking on the back panel just above the jack for the power cord. One of the two squares will be marked to indicate the input voltage for which the equipment has been set. Check the marking against the voltage of the power source to be used. If they do not agree, remove the top cover by removing retaining screws and pulling it to the rear. Then remove the rear safety shield to expose Terminal Blocks A and B. Refer to Figure 6, and change the jumpers on Terminal Block A to the form shown for the input voltage to be used.

The high-voltage connector for the treating pulse, located on the front panel, is always active. The one on the rear panel may, or may not be active depending upon the placement of jumpers on Terminal Block B. Figure 7 shows the jumpers needed if the rear-panel connector is to be used.

Replace the safety shield and top cover. Be certain that the safety interlock, mounted on the top cover, is in place.

Depending upon the system used, connections should be made at the rear-panel jack for gaussmeter analog input, BCD input, address input, and bus interface (See Figure 8).

Connect a treating coil to the appropriate output jack.

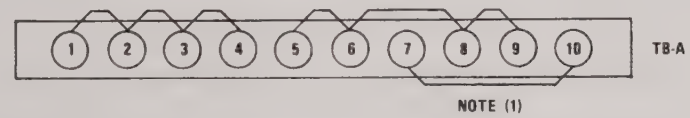
Switch input POWER to OFF and install the power plug in an appropriate output receptacle.

REMOVE YOUR WATCH

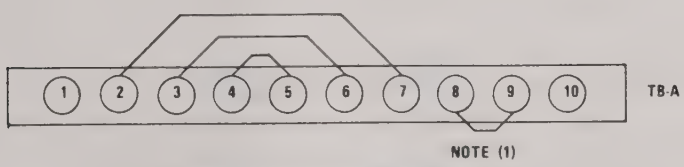
Do not wear a watch while operating the Magnetreater®. The strong magnetic field may damage the timepiece.

OPERATIONAL CHECKS

The following procedures will check the operation of the equipment and familiarize the user with its operation. Figure 15 shows the schematic diagram which is helpful in the following discussion.



CONNECTIONS FOR 115-V OPERATION



CONNECTIONS FOR 230-V OPERATION

NOTE (1) This jumper must be in place unless a power source with grounded neutral (two hot legs) is used.

Figure 6. Connections at Terminal Block A for adjusting for primary-power voltage

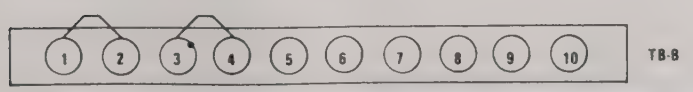
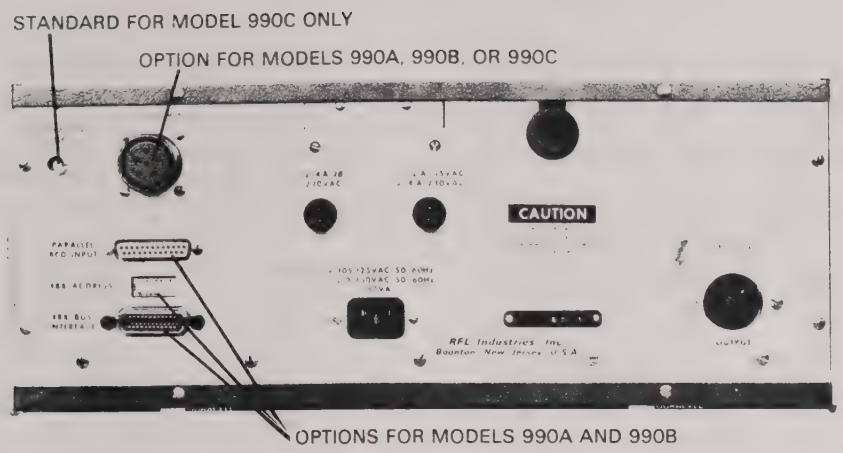


Figure 7. Connections at Terminal Block B for activating rear-panel output connector or for adding supplementary, external capacitors to energy-storage bank



NOTE — REAR PANEL COMPONENTS ARE STANDARD FOR ALL MODELS EXCEPT AS SHOWN.

Figure 8. Identification of 990 Series rear panel

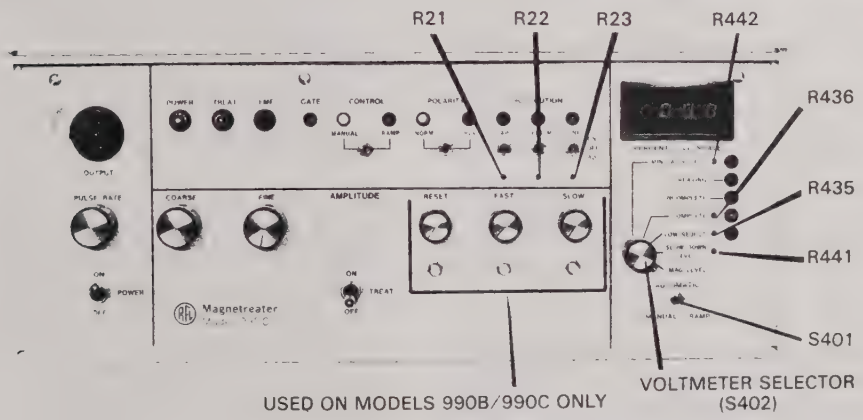


Figure 9. Identification of Model 990B and 990C front panel controls

Manual Operation

Front-panel controls are identified in Figure 9. Before turning on power, set controls as follows:

CONTROL switch	MANUAL
POLARITY	NORM
RESOLUTION	All at ON
S402	MAG LEVEL (Model 990C only)
AUTOMATIC (S401)	MANUAL/RAMP (Model 990C only)
SLOW	Full CCW (Models 990B/990C only)
FAST	Full CCW (Models 990B/990C only)
RESET	Full CCW (Models 990B/990C only)
TREAT	OFF
FINE	Midrange
COARSE	Midrange
PULSE RATE	Midrange

(1) Connect treating coil to output. Switch POWER to ON. Note that POWER lamp illuminates.

(2) Switch TREAT to ON. Treating pulses will start and TREAT lamp will illuminate.

(3) Vary the COARSE amplitude control and note the wide range of amplitude as indicated by the loudness of the thump from the treating coil. Return to midrange.

(4) Vary the FINE amplitude control. There should be a small change in pulse amplitude. Return the control to its mid-position.

(5) Vary the PULSE RATE control. The pulse rate will change over the range of approximately 40 to 130 pulses-per-minute. Leave the control in the full CCW position, and set TREAT to OFF.

(6) Switch POLARITY from NORM to REV. The polarity indicators will change and relay K1 can be heard to operate. Switch TREAT to ON. Note that both elements of the neon TREAT lamp glow, that the EMF lamp (which monitors capacitor voltage) glows, and that the GATE lamp glows at the start of each treating pulse.

(7) Switch the three RESOLUTION switches to OFF, which is their center position. Observe that even though the TREAT lamp is illuminated the treating pulses either stop or occur infrequently. If treating stops, this indicates that the input charging current of the storage capacitors has been exceeded by the current through the bleeder resistors.

(8) Switch FINE resolution to ON, and observe that pulsing starts.

(9) Switch MEDIUM resolution to ADJ and observe that the MEDIUM lamp blinks during the early portion of the charging cycle for the storage capacitors. It also extinguishes when the charge reaches the level set by the MEDIUM trip-level adjustment, R22, which is found immediately below the switch. Charging current passes through charging resistor R14 and reduces the charging time when the MEDIUM lamp is illuminated.

As the charging current is reduced, the resolution of the amplitude at which the treating pulse is fired is improved, and the precision with which the desired magnetic level is approached is improved. Thus, the three resolution switches provide for rapid charging (COARSE) for the early part of the charging cycle, a modest charging rate (MEDIUM) later in the cycle, and a slow charging rate (FINE) at the end of the charging cycle. The energy levels, at which each change is made, are set by the screwdriver - adjust potentiometers accessible through holes in the front panel immediately below each resolution switch.

(10) Switch COARSE resolution to ADJ and observe that the COARSE indicator glows during the early part of the charging cycle. It has been adjusted to switch off slightly before the MEDIUM indicator and resistor are switched off.

(11) Return all three resolution switches to their ON positions.

(12) Switch TREAT to OFF.

Operation with Dual-Slope Control

(1) Switch CONTROL to RAMP.

(2) Set POLARITY to NORM.

(3) Set RESET, FAST, and SLOW full CW

(4) Set COARSE and FINE to midrange.

(5) Set all RESOLUTION switches ON.

(6) Set AUTOMATIC (S401) to MANUAL/RAMP.

(7) Turn PULSE RATE full CCW.

(8) Set TREAT to ON.

(9) Momentarily press RESET button.

(10) Depress and hold FAST button, observe that initial pulse is nearly maximum, and that after only a few pulses the Magnetreater® becomes inhibited. This is the normal case. When the equipment must continue treating after the dual-slope integrator saturates, the circuit is wired according to Note 2, Figure 17 and the circuit will not inhibit.

(11) Press the RESET button and repeat the cycle.

(12) Press and hold RESET while turning the RESET knob full CCW. Then release the button.

(13) Press and hold the FAST button, and observe that pulses start with low amplitude, progress to maximum amplitude, and then stop. Release the FAST button.

(14) Press RESET momentarily.

(15) Press and hold the SLOW button. Observe that the cycle starts with pulses of low amplitude, progresses slowly to maximum amplitude, and stops when the integrator saturates. Holding FAST and SLOW buttons simultaneously provides an intermediate rate.

(16) Turn FAST and SLOW ramp controls fully CCW. Observe that incremental increases in amplitude from pulse-to-pulse are very small. By selecting both a small ramp increment and fine resolution, the operator can terminate treating at a very precise magnetic level.

Note that the dual-slope reference generator holds its last value whenever the treating is stopped by releasing the pushbuttons. This permits the operator momentarily to touch either pushbutton just once for a single pulse. This feature will be found useful in certain applications.

Automatic-Module Operation

Front-Panel Set-up

Connect the Model 990C with gaussmeter and treating fixture as a system. Be certain that the analog output from the gaussmeter is connected to the analog-input jack at the rear panel (see Figure 8).

The program for the treating cycle can be established by individually setting the following points which are depicted in Figure 9.

(1) Turn S402, the voltmeter selector, to MIN SAT REJECT. This is the minimum acceptable flux-density level that makes the saturated magnetic product acceptable for treatment. With a screwdriver adjust R442 until the voltmeter reads the desired flux-density level expressed as a percentage of full scale of the gaussmeter.

(2) Turn S402 to LOW REJECT. With a screwdriver, adjust R435 so that the voltmeter reads the lowest acceptable flux-density level expressed as a percentage of full scale.

(3) Turn S402 to COMPLETE. With a screwdriver adjust R436 density level expressed as a percentage of full scale.

(4) Turn S402 to SLOW DOWN LEVEL and similarly adjust R441 for the flux-density level at which the incremental increases in ramp amplitude are to be decreased for improved resolution as the process approaches its end-point. Adjust R441 to read the slowdown level as a percentage of full scale on the gaussmeter.

(5) Turn S402 to MAG LEVEL. This position causes the voltmeter to repeat the reading of the gaussmeter continuously.

This completes the level-setting process using the front panel controls.

Internal Set-up

This supplemental procedure should be performed after completing the aforementioned Front-Panel Set up procedure as a quick way to simultaneously re-set all the trip levels when treating a batch of different magnets. In this manner, one may easily re-set the min sat, slow down, upper level and lower level trip points while maintaining constant ratios. This permits treating a new magnet after only one internal adjustment (R313), on the automatic module. Refer to Figure 13.

(1) Remove two screws from the top panel and slide cover back to provide access to the automatic module and PC boards located behind the front-panel DPM.

(2) Using a screwdriver, adjust the GAIN potentiometer (R313) and REFERENCE potentiometer (R318) for the desired trip-point level. Both potentiometers are located on the automatic module PCB which is the first PC Board from the front of the panel.

This adjustment is used to set the trip-point as a function of input voltage from the gaussmeter, eg, . 1V, 3V, etc. Adjusting R313 simultaneously sets the reference level on the four comparators which provide proportional gain limits for — MIN SAT REJECT, upper level, lower level, and slow-down. This allows all four comparator levels to be moved proportionally, up or down, at the same time.

If desired, the front-panel DVM may be adjusted for a particular reading as follows:

(3) With a screwdriver, adjust the Full Scale trim adjust potentiometer (R402) for calibration of the front-panel meter. Potentiometer R402 is located on the DVM PCB, just behind the front panel meter. This adjustment is used for full-scale meter calibration, but has no effect on reference level trip points aforementioned in step (2).

This completes the supplemental level-setting process. Replace top cover and secure, using the two screws previously removed.

Treating a Magnet

Place a saturated magnet in the treating fixture. Normally, the MIN SAT REJECT lamp will extinguish and treating will start automatically. As the flux density of the product is decreased, the automatic module will shift to the slowdown mode, in which incremental increases in pulse amplitude are decreased and the coarse-resolution resistor is switched off.

Normally, treating will continue until the green COMPLETE lamp illuminates and treating stops automatically. If the flux-density level of the piece settles above the limit set by the COMPLETE adjustment (Step 2, front-panel set up procedure), treating will continue. If this level settles between the COMPLETE level and the LOW REJECT level, the product has been properly treated. If it settles below the lower level, the LOW REJECT lamp will illuminate to indicate the product has been overtreated. In this case, the window for acceptance may be too narrow, the slowdown point may be set too high, or the sensing probe may have been shifted from its original position.

If the dual-slope integrator which is controlled by the automatic module saturates, the INCOMPLETE lamp will illuminate. This indicates that no further treating can occur unless some means is provided for increasing the density of the demagnetizing flux.

IEEE-488 Option

For Models 990A/990B having the IEEE-488 option, check that the interconnecting card assembly has been installed and that cabling is in place. See Figures 10 and 11. Install and connect the gaussmeter, probe, and fixture. If the system so requires, install and connect the programming relay and the magnet charger. Install the IEEE-488 Bus controller (Apple II computer, or equivalent) and the interconnecting bus cable.

Check settings of the address switch on the rear panel to make sure they agree with the program for the controller. Table 3 shows the function of each section of the 8-position SPST switch. When a switch is in the ON position it is closed (conducting), representing a logic zero. In the off position, the switch is open (non-conducting), representing a logic one. The black dots on each switch in Table 3 represent the locations of the raised portion of the switch's slider; the arrangement shown in this table is that most frequently used in instruments leaving the RFL plant.

When Switch 6 of the address array on the back panel is in the ON position (logic zero), the interconnecting card is in the addressable mode. Switches 1 through 5 determine the address of the equipment. For addressing, select an unused address between 0 and decimal 30. Convert it to binary form, starting with the least-significant bit at Switch 1. Set the switch to ON if the address is to be a logic zero, or to off if a logic one. In this mode, the system will respond to the address sent to over the bus by the system controller. It will respond only to the address programmed as above. In this mode, the interface will automatically send the SRQ message over the bus whenever data are present at the bus coupler, even though the coupler is not addressed as a talker. To inhibit the SRQ message, set Switch 7 to the ON position.

Table 4 is essentially a duplication of Table 3, excepting that it carries model and serial number of a particular instrument. This additional information defines the actual arrangement required for a particular application. These markings will appear in the instruction manual shipped with each individual instrument.

Jumper DR is located on the interconnecting board near the end of connector P4; normally jumpered in position A. In the A position, DATA READY (P3 pin 8) is supplied from the gaussmeter display. This avoids the occasional errors which would occur if the input latches were not sync-ed with the BCD output.

When jumper DR is in position B, an internal DATA-READY signal providing the same junction as mentioned above (for position A), is generated from the ICS coupler module, itself.

To utilize this function one must generate a GET (group execute trigger) command just prior to inputting of any outside data.

Table 3
FUNCTIONS OF POSITIONS OF ADDRESS SWITCH

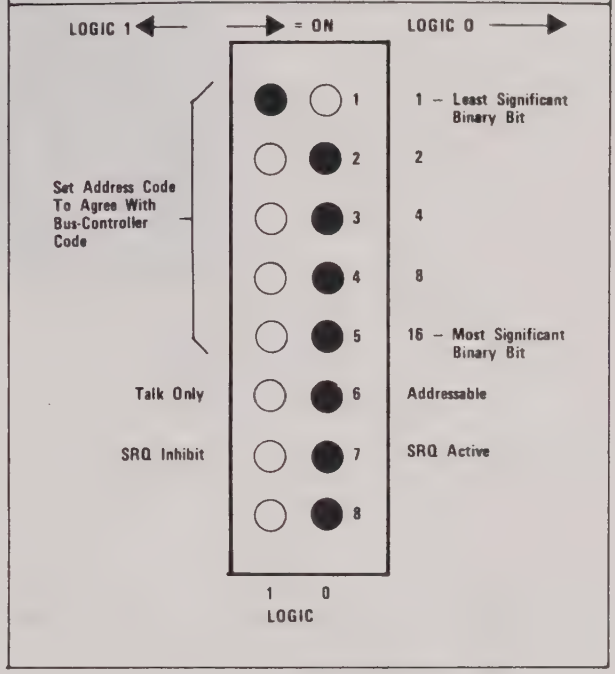
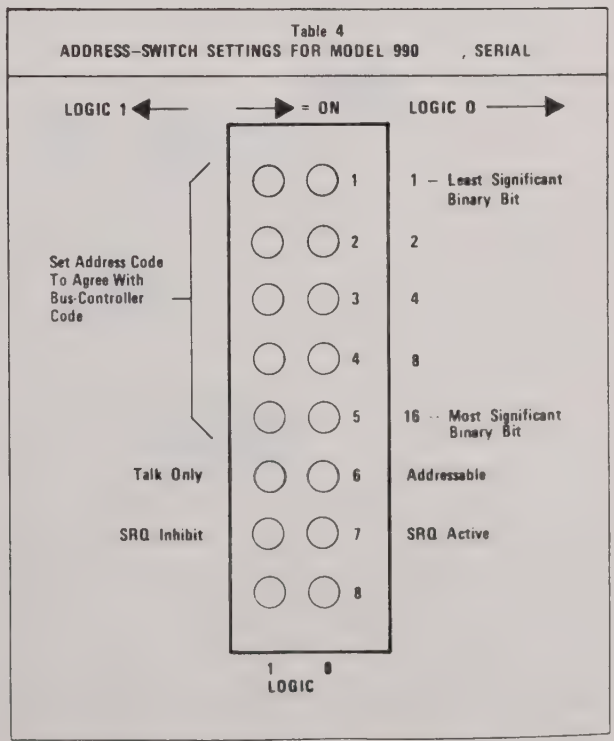
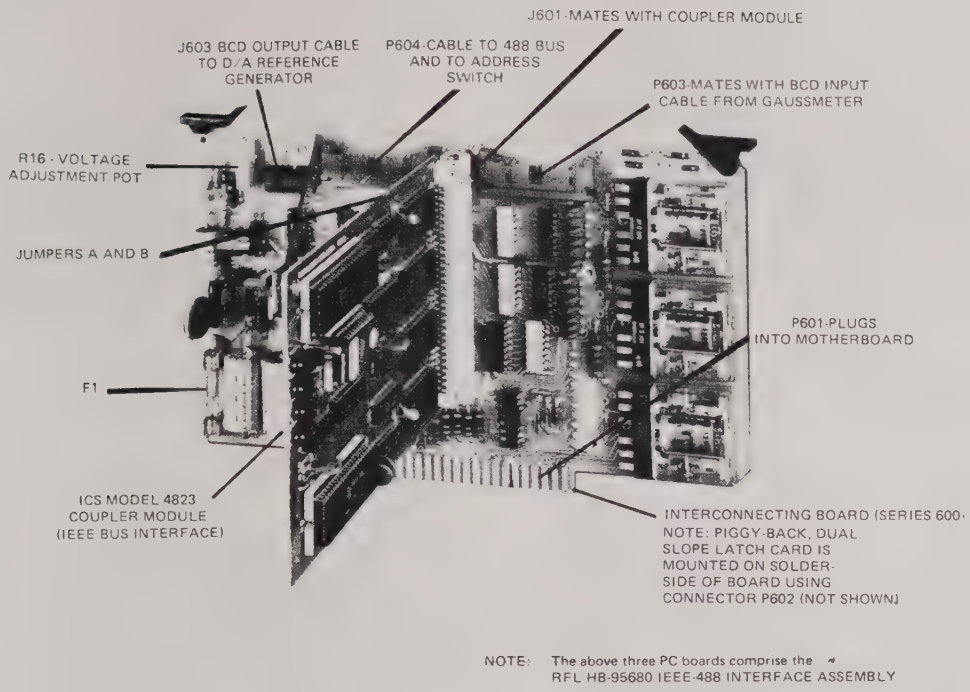


Table 4
ADDRESS–SWITCH SETTINGS FOR MODEL 990 , SERIAL




J601-MATES WITH COUPLER MODULE
J603 BCD OUTPUT CABLE TO D/A REFERENCE GENERATOR
P604-CABLE TO 488 BUS AND TO ADDRESS SWITCH
P603-MATES WITH BCD INPUT CABLE FROM GAUSSMETER
R16 - VOLTAGE ADJUSTMENT POT
JUMPERS A AND B
P601-PLUGS INTO MOTHERBOARD
F1
ICS MODEL 4823 COUPLER MODULE (IEEE BUS INTERFACE)
INTERCONNECTING BOARD (SERIES 600)
NOTE: PIGGY-BACK, DUAL SLOPE LATCH CARD IS MOUNTED ON SOLDER-SIDE OF BOARD USING CONNECTOR P602 (NOT SHOWN)

NOTE: The above three PC boards comprise the RFL HB-95680 IEEE-488 INTERFACE ASSEMBLY

Figure 10. Location and function of plugs and jacks on Interconnecting Card HB-96685

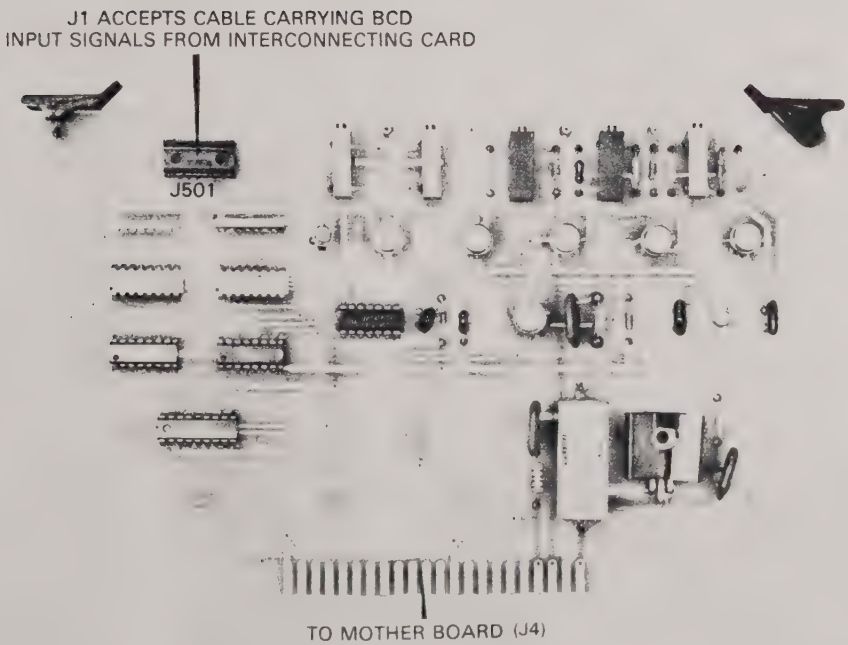


Figure 11. Location of jack for BCD-output cable to Digital-to-Analog Reference Generator HB-96695

CAUTION

To avoid exposure to hazardous voltages, observe procedures given on Pages iii and iv.

Tables 5 and 6 show pin designations and functional assignments to each line at the connector between the ICS Electronics Corp., Model 4823 Bus Coupler Module and the interconnecting board.

Status Indicators

The bus-coupler module has four, edge-mounted light-emitting diodes (LED) to aid the user in verifying proper operation of the system. These are:

(1) PWR: Illuminates when the module has 5-Vdc power applied to it and has passed the power-on-self test.

Table 5
ICS Bus-Coupler Outputs (Treater Listening)

Operating Function	Digit	Interconnecting Board Terminal Designation	Bus-Coupler Channel	Bus-Coupler Terminal J601	Function of Line	
MSD	1	19-20	CH1	A30	Energizing Relay	
	2	21-22	CH2	A29	Firing Relay	
	4	17-18	CH3	A28	Programming Relay	
	8	J	CH4	A27	Treat ON/OFF	
	1	U	CH5	A31	Fast	
	2	V	CH6	A26	Slow	
	4	W	CH7	C27	Reset	
	8	J603-16	CH8	B27	Trigger (Spare)	
	1	J603-15	CH9	A25	Inhibit (Spare)	
	2	N	CH10	C26	Retrigger	
	4	L	CH11	B26	Halt	
	8	X	CH12	C25	Reverse Relay	
	1	J603-2	CH13	C24	1000	
	2	J603-1	CH14	A23	−2000	
	4	R	CH15	A24	Slowdown	
	8	13	CH16	B25	Alarm (Spare)	
	1	J603-6	CH17	A19	100	3½-digit BCD to D-to-A Reference Generator
	2	J603-5	CH18	A20	200	
	4	J603-4	CH19	C20	400	
	8	J603-3	CH20	B21	800	
	1	J603-10	CH21	B20	10	
	2	J603-9	CH22	B15	20	
	4	J603-8	CH23	C15	40	
	8	J603-7	CH24	B16	80	
LSD	1	J603-14	CH25	C16	1	
	2	J603-13	CH26	A17	2	
	4	J603-12	CH27	C18	4	
	8	J603-11	CH28	A18	8	

(2) RDY: Illuminates when the inputs on the two status lines match the user's selected logic levels.

(3) MTA: Illuminates when the module has recognized its TALK address, or when it has been placed in a TALK ONLY mode.

(4) MLA: Illuminates when the module has recognized its LISTEN address, or when it has been placed in a LISTEN ONLY mode.

These four indicators are on the edge of the coupler card nearest the rear panel. They are shown in Figure 12.

Table 6

ICS Bus-Coupler Inputs (Gaussmeter and Treater Talking)

Operating Function	Digit	Interconnecting Board Terminal Designation	Bus-Coupler Channel	Bus-Coupler Terminal J601	Function of Line
MSD	1	—	CH29	A16	Treating Gate
	2	—	CH30	B17	Lo — 2200 ohms
	4	—	CH31	C17	Lo — to +5V
	8	—	CH32	B18	Lo — (Note 1)
	1	J603-18	CH33	B14	– Polarity
	2	—	CH34	C14	Lo
	4	—	CH35	A15	Lo — 2200 ohms to +5V (Note 1)
	8	—	CH36	A14	Lo
	1	J603-7	CH37	A13	1000
	2	—	CH38	C13	Lo
	4	—	CH39	B13	Lo — 2200 ohms to Gnd.
	8	—	CH40	C12	Lo
	1	J603-5	CH41	B12	100
	2	J603-16	CH42	A12	200
	4	J603-6	CH43	C11	400
	8	J603-17	CH44	B11	800
	1	J603-3	CH45	A10	10
	2	J603-14	CH46	B10	20
	4	J603-4	CH47	C10	40
	8	J603-15	CH48	A11	80
	1	J603-1	CH49	B6	1
	2	J603-12	CH50	C6	2
	4	J603-2	CH51	B7	4
	8	J603-13	CH52	C7	8
LSD	1	J603-21	CH53	C5	0.1
	2	J603-22	CH54	B5	0.2
	4	J603-23	CH55	C4	0.4
	8	J603-24	CH56	B4	0.8

3½ or 4½ digit BCD from Gaussmeter

Option, parallel or Hi 2200 ohms to +5V

Note 1:
When MSD and the next following digit are not used, all eight inputs are tied, through 2200 ohms to +5Vdc. This causes the leading zeros to be suppressed.

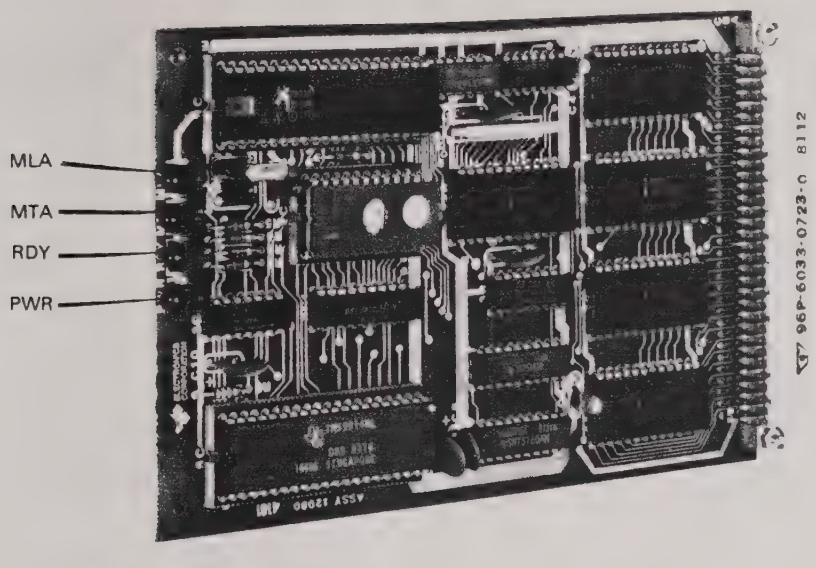


Figure 12. Location of supervisory lamps on ICS Bus-coupler module Model 4823.

The IEEE-488 Bus option will function with different bus controllers. As an example; the Apple II, the Systron-Donner Busser, or Hewlett-Packard Model 85 may be used. The program for each of these has operator-prompting notes to guide the operator to each successive action.

The best way to become familiar with the system is to install the disc, tape, or cartridge for the program. Then turn on all equipment. By following the prompting notes, it should be easy to operate the system and to understand how to adjust it to the user's requirements.

Programs are written in Basic, and a modest amount of study enables the user to customize a program for his application. One can adjust delay times, delete inapplicable steps, adjust width of the acceptance window for the flux-density level to trade between accuracy and speed, and add programming notes as needed.

Digital-to-Analog Reference Generator HB-95695

When using a Model 990A with auto-digital/bus features be certain that the reference generator is installed in the second circuit-card slot from the front panel and that the required 16-wire ribbon cable connects it to J603 of the interconnecting card.

To set the level of the treating pulse, numbers from 1999, decreasing through zero to –1999, are entered through the bus-controller program, or through the keyboard. These are then forwarded, in parallel BCD format, along the ribbon cable to the D-to-A reference generator. The analog output is available at Test Point 5, which is the end of R7 nearest to the edge-connector fingers. A more negative number calls for a greater amplitude of treating pulse.

Some systems are set up to start with the smallest treating pulse for 12 volts of analog-reference output when digital 1999 is entered, then going through mid-amplitude for zero volts reference when digital 0000 is entered, and on to maximum-amplitude pulses for–12 volts of analog-reference output when digital –1999 is entered.

Another common system is set up with a voltage offset so that the minimum treating pulse occurs with zero analog-reference voltage following a digital entry of 1999. Mid-amplitude treating pulses occur when the analog voltage reads –4 volts in response to a digital input of 0000. And maximum-amplitude pulses occur when the analog voltage is –8 volts with a digital input of –1999.

A test program can be set up that will call for a negative-going output starting at 1999 and going to –1999 in uniform steps. The analog-voltage output should track with uniform steps, and with no gaps or reversals.

Table 7 shows the interconnecting lines between the D/A Reference Card (J501) and Interconnect Card BCD output connector (J603), with pin assignments.

Table 7

Interconnect Card, BCD Output (J603) - Pin Assignments

J603 (To D/A Ref. Gen.)	D/A Card J501	Signal Description	
14	14	1	BCD OUTPUT
13	13	2	
12	12	4	
11	11	8	
10	10	10	
9	9	20	
8	8	40	
7	7	80	
6	6	100	
5	5	200	
4	4	400	
3	3	800	
2	2	1000	
1	1	+/−(2000)	
15	15	*Inhibit	
16	16	Spare	

*If the ICS, IEEE-488 Interface is used with the Dual Slope Module, INHIBIT is automatically generated by releasing the SLOW and FAST buttons.
When the D/A Reference Generator Module is used, the INHIBIT signal is at Pin A27 (8=RUN; 0=INHIBIT), and is connected to the NORMAL INHIBIT on Pin 22 of J2 on the mother-board.

MAINTENANCE AND REPAIR

WARNING

Voltages on full charged capacitors can cause death. Regardless of meter reading or numerous safety devices employed, DO NOT troubleshoot before making sure capacitor bank is discharged. Tape a 10K ohm 25 watt wirewound resistor to a 1-foot bakelite rod and short the capacitors with it for 30 seconds.

SAFETY PRECAUTION

If possible, perform all internal maintenance operations with the ac power disconnected from the equipment. To troubleshoot the equipment, it may become necessary to block the interlocks with insulated metal tabs. If this is done, standard high-voltage test procedures must be adopted. Instruments are connected and removed with power off. Do not troubleshoot with power on until resistance checks with an ohmmeter have been made on the questionable circuit.

GENERAL

Under normal operating conditions the Series 990 requires no daily maintenance. After 1000 hours of operation, the contacts on all relays should be checked and burnished.

The metal chassis panel and cover are not connected to any part of the operating circuit. These parts are connected to the grounding lead in the three-wire power cable. A so-called "floating ground" circuit is used, thus protecting personnel from shock hazard in the event of a high-voltage breakdown. During routine checks it is advisable to be sure that the ground lug on the power plug is making good electrical connection to the metal panel and cover. For location of major components on the 990 Series refer to Figure 13.

When checking the high-voltage circuits with a voltmeter, observe the following procedure:

(1) Stand on an insulated pad.

(2) Make connections while using only one hand. It is advisable to keep the other hand in one's pocket to prevent touching a live circuit or the case of the equipment.

(3) Connect the voltmeter to the circuit to be measured.

(4) Turn on the equipment and observe the voltage reading. Do not touch voltmeter leads or equipment while energized.

(5) Turn equipment off and, after waiting one full minute, short-circuit the storage capacitors using the shorting device recommended.

(6) Remove voltmeter leads from circuit.

TROUBLESHOOTING

In the event that the treater fails to operate, the following procedures for diagnosis of trouble are recommended. The sequence, from the most generalized to the most specific tests, is chosen to maximize the likelihood of location of the fault to a well-defined area of the circuit as early as possible.

Preliminary Checks

(1) Check that power cord is plugged into an active outlet of proper voltage.

(2) POWER to ON. POWER lamp should illuminate. If not, turn POWER off, disconnect power input. Check for blown fuses F1 and F2 and for defective lamp. Replace as necessary. When fuses and lamp are in good condition, check protective interlock. Then repeat Steps 1 and 2. If POWER ON now illuminates, proceed to Step 3. If not, proceed to detailed analysis.

(3) POWER to ON. Then operate the equipment manually through a treating cycle. If the fixture is electrically continuous, then an audible thump should be heard.

(4) If no thump is heard, it is likely that (a) the control circuits are faulty, (b) the firing circuit for Q8 is faulty, or (c) that triac Q8 has reached the end of its useful life.

(5) The control and firing circuits may be checked by using standard, signal-tracing techniques while observing the precautions given in the section following, titled Detailed Analysis.

(6) If the control and firing circuits are operating satisfactorily, it is then likely that the triac is defective. If the tests have reached this point, it is advisable to replace the triac before proceeding further.

CAUTION

Observe safety precautions stated at the beginning of this Chapter and on Pages iii and iv of this manual.

Replacing the Triac

(1) Prepare a shorting tool by taping a 10K-ohm, 25-watt resistor to the end of a one-foot length of bakelite rod. Extend a two-foot lead, terminated with a clip for grounding, from the near end of the resistor. Terminate the far-end of the resistor with about six inches of Size 14 AWG wire, which will serve as a probe.

(2) Switch POWER to OFF. Remove power cord from outlet.

(3) Remove the protective covers from the treater.

(4) Using the high-voltage techniques described at the beginning of this chapter, connect a voltmeter across each capacitor to check for the presence of voltage. DO NOT turn on power.

(5) If voltage is found across either capacitor one should use the shorting tool described earlier. In any event, proceed no further until both capacitors show no voltage across their terminals.

(6) Place a clip-lead across each capacitor, and if any difficulties have been experienced while discharging, repair as necessary.

(7) Remove and replace the triac.

(8) Remove the shorting leads from the capacitors, replace covers, restore power, and test for operation.

(9) If equipment fails to operate, proceed with Detailed Analysis, following.

Detailed Analysis

At this point, the usual procedures for first identifying and then isolating the trouble must be undertaken. Remove the power plug from its supply and remove all protective covers to gain access to the equipment. Then repeat Steps (1) through (6), immediately foregoing, to discharge the capacitors. DO NOT OMIT THESE STEPS.

Interlocks removed with the cover can be replaced with interlock connector, RFL P/N HA-6109.

It is important that one be familiar with the mode of operation of each set of circuits in the equipment, and it is suggested that a review of the section titled CIRCUIT DETAILS be made.

Note that most major components can be checked for continuity and leakage without applying power, using simply an ohmmeter. This includes the capacitors in the energy storage banks. Bear in mind that the control circuits on the front panel, the comparator board, the dual-slope board, and other circuit boards can be checked without energizing the capacitor-charging circuit. Both capacitors can be easily disconnected from their charging source by disconnecting the cable carrying current to T3.

One should attempt to isolate the fault to a particular section of the circuit and then, to identify the defective component. The schematic of each circuit is an invaluable guide to this work.

Access to the circuit boards is through the top of the cabinet. A Card Extender, available from RFL, is necessary for access to these boards while connected in the circuit. Those who prefer not to service these boards may wish to inventory plug-in boards as replaceable spares.

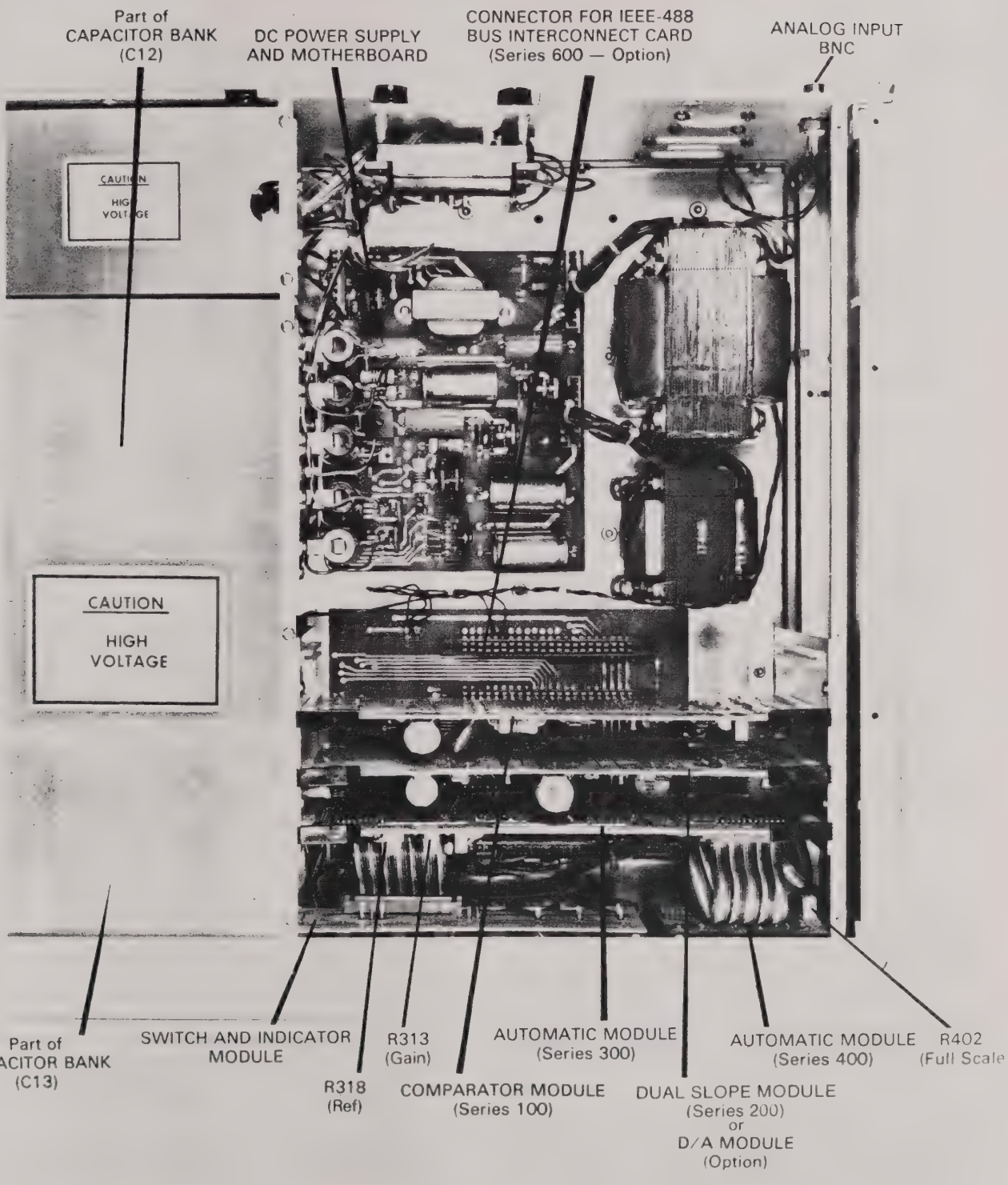


Figure 13. Location of major components, 990 Series

CIRCUIT DETAILS

A discussion of the operation of the circuits of the 990 Series divides logically into several groups, and these correspond to the physical divisions of the design. The main frame carries the control panel, back panel, and all of the high-power, high-voltage components. It can also contain up to five plug-in circuit boards which generate control, logic, and bus-interface signals, and which isolate these functions from the high-power circuits. Each is discussed separately.

The philosophy of the design and the major circuit elements used for this magnet treater are outlined in the block diagram, Figure 5. It is important to keep this plan in mind while following the discussion of the circuits.

The eight schematic diagrams, used to describe the circuit are Figures 15 through 22. Each (except Figure 15) has marginal locators, used to establish coordinates for designating the approximate location of circuit items discussed. Thus a notation, such as (E3), following mention of an item in the text, indicates that the item will be found on the schematic in the rectangle outlined by the intersection of Bands E and 3.

Figure 15, the schematic of the main frame, shows all interboard connections. These data will be useful when tracing logic, control, and power circuits through the equipment. It is also helpful to note that circuit-symbol numbers of all components on the main frame are below 100, and that the number series is different on each plug-in circuit card.

MAIN FRAME

The circuits and components of the main frame are shown in Figure 15.

Power Circuits

The main power switch, S1 energizes the equipment through fuses F1 and F2 and a safety interlock which opens when the top cover is removed. When the equipment is powered from a source with one leg grounded, a jumper must be installed between Terminals 8 and 9 of Terminal Block A to provide for the requirement that the ground is never opened. For sources with a grounded neutral, the jumper is omitted. When power is on, the neon supervisory lamp, I1, on the front panel is illuminated.

Transformer T1 powers positive and negative regulated 12-Vdc circuits used to operate most of the control circuits.

Transformer T3 is the high-power transformer used to charge the energy-storage bank, C12 and C13 to any controlled voltage up to 600V. The primary of T3 is switched on and off by triac Q3. This triac is controlled by a floating, isolated source using transformer T2, driver transistor Q1, and optical isolator IC5. The optical isolator is controlled by circuits on the comparator board.

Resistor R12, and triac Q5 are in series with one side of the charging circuit for the energy-storage capacitors. R13 and Q6, and R15 and Q7, are similarly connected. Each provides a controlled charging rate for the capacitors, and the rate is determined by how many triacs are made conducting, as controlled through the comparator board. When Q5, Q6, and Q7 conduct, the charging rate is fastest, so that the end point of the treating process is approached, though not reached, as quickly as feasible. In succession, Q5, and then Q6, become nonconducting, and the charging rate is slowed with their higher resistors so that the end point is approached with the best possible resolution.

Triac Q8, controlled from the comparator board, discharges the energy into the treating coil.

Bleed Control Option

Components C15, Q10 and R18 (Figure 15, sheet 1 of 2) can be used to open or close the current path of bleeder resistor R18. When the path is open, a higher level of treating control precision is obtainable. In this case, the bleeder current will swamp out (override) the charging current. Consult factory for details.

COMPARATOR BOARD HB-95610

The comparator board, the schematic circuit of which is shown on Figure 16, performs all basic control functions for the system except for automatic controls. Most functions are accomplished by comparing a variable voltage against a preset taraget level in an operational amplifier used as a comparator.

Manual Operation

In manual operation, the reference level for the pulse which fires triac Q8 to release the treating pulse is set by the COARSE and FINE controls on the front panel. Their voltage level is buffered by IC105D (A5). The range of the two front-panel controls may be set with R153 (B6), which controls the gain of IC105D. The reference-voltage output of IC105D is compared against the voltage on the storage capacitor in IC103C (A4), as described in the following paragraph.

Resistors R19 and R20 (Figure 15), form a voltage divider across the storage capacitors, and this sense voltage appears at J3 pin 16 (Figure 15). IC105C (A4) is a voltage follower which drives a precision rectifier using IC105B and IC105A. This rectifier removes the ripple from the source driving the storage capacitors. The output of IC105A is compared against the negative reference voltage at IC103C-8. When comparator IC103C changes state at Pin 4, it triggers IC102 (C1), a timer which generates a 50-ms gate.

This is passed through Q106 and Q105 (D1) to fire Q8 and release the treating pulse.

Simultaneously, this 50-ms pulse is passed both to the inhibit bus and to timer IC104 (C6) which delivers a pulse to the inhibit bus. These pulses inhibit the charging voltage during the discharge time. This time constant is established by C102, R109, and R27 (the PULSE RATE control on the front panel).

The rectified sense signal is also compared, in IC101A, IC101B, and IC101C (C3-5), with reference levels set to determine the points at which the charging rate changes from COARSE to MEDIUM, and from MEDIUM to FINE. The reference levels are set with potentiometers R21 (COARSE), R22, (MEDIUM), and R23 (FINE), on the front panel. The triacs on the main frame controlling the coarse, medium, and fine resistors, are controlled by Q102, Q103, and Q104, respectively.

The three front-panel switches, S3, S4, and S5, are three-position switches. In their ON (up) positions, their respective triacs, Q5, Q6, and Q7 are conducting and the charging resistors are always in series with the charging circuit. In their center position, the triacs are not conducting. In their ADJ position, each resistor is controlled through its respective comparator, and its period of conduction during the treating cycle is under control of the comparator.

A logic high on the inhibit bus (C7) causes the output of comparator IC103A (C6) to change to a high state. This turns off the power-input control triac, Q3. The inhibit signal can come from the firing signal to the gate, from the timer, IC104, or from an external signal. Terminal 5 (C8) permits inhibiting with a logic high. Terminal E permits inhibiting with a logic low.

External Treat Pulse Sync

The aforementioned internal trigger signal may be blocked for applications that require synchronization of the treat pulse to an external trigger. The signal is blocked by connecting Pin 21 (normally open) to ground.

DUAL-SLOPE CONTROL MODULE HB-95620

A schematic diagram of the circuit of the Dual-Slope Control Module is shown as Figure 17.

Ramp Generator

At the output of this control card, Terminal L, a negative-going ramp signal, generated by an integrator, of which IC205 is the active element, controls the level to which the energy-storage capacitors charge. As the magnitude of the ramp voltage increases negatively, the charging level increases, the stored charge increases, and the demagnetizing, or treating, pulse increases in amplitude.

The level of the first demagnetizing pulse is determined by setting the initial condition of the integrator by using the START LEVEL control, R34. Then, when RESET, S3, is pressed momentarily, Pins 5 and 9 of IC202 are disconnected from ground, and Pin 5 is connected through Pin 4 to reset-level voltage from IC204-6.

The time-rate of rise of voltage across the integrating capacitor, C201 (C4), is determined by the magnitude of input current flowing to that capacitor through summing resistor R211. A faster rate of rise, which gives a greater incremental increase in amplitude of the treating pulse, is set with R32, the FAST control, and the current thereby set flows to the integrating capacitor when solid-state switch IC203A (C6) becomes conducting by applying a logic zero to its Pin 2.

A slower rate is obtained by setting R33, the SLOW control, to the desired level. The current level thereby set flows to the summing resistor through solid-state switch IC203 (B6) by applying a logic zero to its Pin 1.

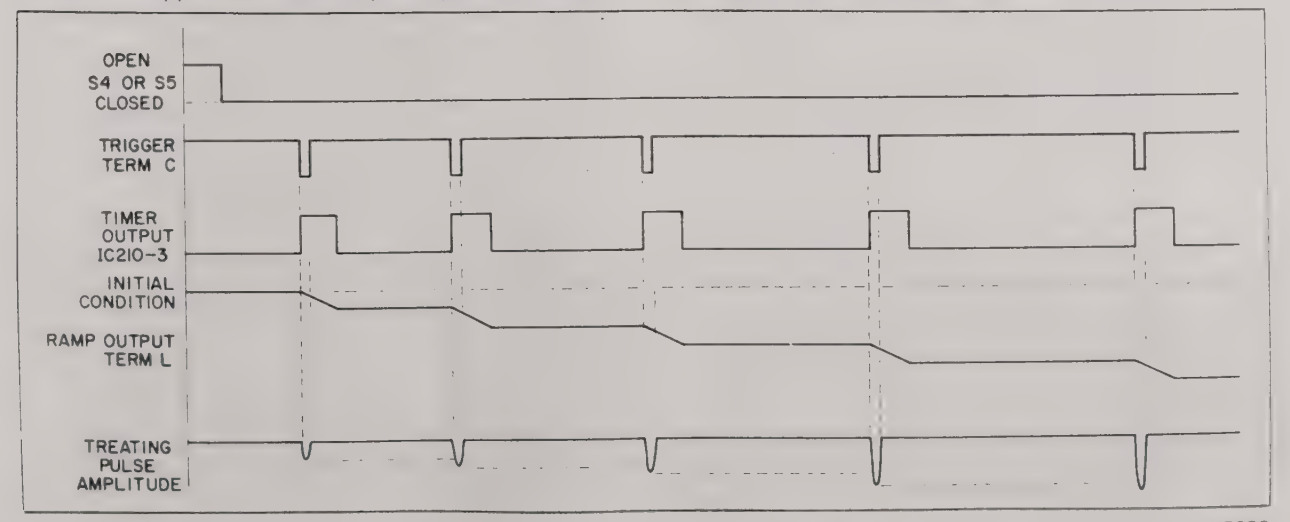


Figure 14. Timing diagram for Dual-Slope Control Board HB-95620

An intermediate rate is obtained when IC203A and IC203B are conducting simultaneously.

The two analog gates are made conducting whenever their respective FAST and SLOW switches, S5 and S4 are pressed and when, and only when, a logic zero is at Pins 8 and/or 12 of IC207 (B6). Then, when a logic zero appears at either of both Pins 9 and 13, either or both control pins of IC203 will go to a logic low. This permits the charge on C201 to move to a new value determined by the settings of R32 and/or R33 and by the period of time for which current to the integrator passes through IC203.

Timing

The timing of each charging cycle of the integrator is set by IC210 (C8). This timer is triggered from the delayed firing signal appearing at Terminal X (A5 on the comparator board) and Terminal C (C8). The duration of each integrating period is set by the time constant of R232 and C211. Integrating periods will continue successively, each generating a somewhat greater treating pulse, so long as trigger pulses are received and so long as at least one treating switch, S5 or S4, is closed. Input current to the integrator will cease when both switches are released by the operator, generally at the end point of the process. Current to the integrator will also cease when the integrator saturates.

A feature of the integrator circuit is that drift is minimized so that the operator may momentarily cease treating, as for obtaining an accurate reading on the gaussmeter, without losing the charging level previously attained. Operation, then, can be continued later with fine resolution.

Figure 14 is a timing diagram showing the development of the treating pulse under control of a negative gate signal at Terminal L. Note that, because each period of integration is controlled by the timer, each incremental increase in amplitude of the treating pulse is exactly the same as the preceding one, regardless of the pulse-repetition rate.

Dual-Slope Inhibit Function

If the integrator saturates before the end point is reached, as may occur when the treating operation is continued indefinitely, the virtual ground between Pins 2 and 3 of IC205 (C5) will disappear and move IC206-2 positive with respect to ground. IC206 is a voltage comparator with a reference of about 50 mV, and when its Pin 2 rises above that level, its output, at Pin 6, changes abruptly from +12 to –12 volts. The logic low so created appears at IC201C-8, which was previously high, so that its output at Pin 10 changes from low to high to furnish an inhibit pulse at Terminal 20. Illumination of the INHIBIT indicator, DS407, signals the operator to check all automatic-control adjustments, including the gaussmeter.

AUTOMATIC MODULE HB-95650

The automatic module is a plug-in card used for automatically treating a magnet to a specified end point without intervention by an operator. To function properly, the plug-in card requires also the voltmeter and control circuits which are an integral part of the front panel of the Model 990C. These are provided on Control-Board Assembly HB-95656, which will be described first.

Control Board HB-95656

This control board (series 400) is mounted immediately behind the front panel, at the right-hand side of the Model 990C Magneteater®. Its schematic is shown as Figure 19.

The digital voltmeter consists of IC401, the voltmeter chip, and a 3½-digit indicator using DS401-404 (B-D, 8-5). Five-volt power for the voltmeter is provided by regulator IC403, which takes its power from a reference diode on the automatic-module card. The voltage to be measured enters voltmeter chip, IC401, at Pin 31. The full-scale reading may be trimmed with R402.

The magnetic flux-density levels desired at significant points in the process are set with R435, R436, R441 and R445 (B-D4). Supervisory lamps DS405-409 monitor the status of the process, and the scaled magnetic level can be monitored by setting S402 to the MAG LEVEL position.

S401 provides for manual or dual-slope operation, which may sometimes be desired, even though the automatic module is installed.

Automatic Module (Main Board)

The schematic circuit of the automatic module (series 300) is shown in Figure 18. The module consists, essentially, of a channel for the gaussmeter signal and a group of comparators which test for certain magnetic levels at different stages of the treating process. The system is augmented with logic gates and timers.

Gaussmeter Channel

The analog gaussmeter signal enters the circuit card at Terminal Z (D8), and it is gated by IC305, a semiconductor switch used to blank the gaussmeter signal during the treating pulse and for a short period thereafter. This switch is opened when the gate for the treating pulse appears at Terminal H (A6), and this pulse starts the blanking timer, IC304 (B6), which holds the switch open for a period determined by the time constant of R327, R328, and C306. The blanking period can be adjusted with R327.

The absolute value of the gaussmeter signal is generated by a full-wave precision rectifier using IC301C and IC301B (D6). Gain of the analog channel is controlled by R113, which is the feedback path of IC301A. This opamp feeds the flux-density-level signal to five, voltage comparators and, through J301-8, to the indicating voltmeter on the front panel.

IC303 (A5) is an optical isolator which provides for an isolated input signal to blank the gaussmeter.

Comparators

The five voltage comparators (C-D4) test the actual, measured flux-density level against reference levels established for critical points in the treating process.

The quiescent state for IC316C (C4) with no treating magnet in the treating fixture is a logic high at Pin 8. This turns off all indicators and resets flip-flop IC309B (D2) whenever the analog-signal level is less than approximately 5% of full scale, as set by R323 and R324 (C5). This indicates that either the magnet is not charged or that there is no magnet in the treating fixture.

The quiescent state for IC317C (D4) with no magnet in the fixture is a logic high at Pin 8. When a properly saturated magnet is placed in the treating fixture, the gaussmeter signal will raise the voltage at IC317C-10 high enough to cause the comparator to change state. Pin 8 then changes to a logic high, IC309B is set, and the treating process starts automatically, through the dual-slope module, with a logic low at Terminal 17 (C1). If the magnet is not saturated to the minimum level required, the process will not start.

When the gaussmeter signal decreases to the SLOWDOWN level, the output of IC317B, which was previously held low by the gaussmeter, moves to a logic high. This closes gate IC312A and opens gate IC312B to put a logic low on Terminal 18 as a signal to the dual-slope circuit to change to the slow mode. At SLOWDOWN, the logic high that simultaneously appears at IC310B-4 (C1) activates Q301 to turn off the fast triac, Q5, through the comparator board, to improve resolution as the end point is approached.

When the gaussmeter signal falls to the COMPLETE level, IC317A-1 will change from low to high. The process will be terminated. Whenever the measured flux-density level is below the COMPLETE level, as determined by IC317A, the logic high at IC317A-1 will pass through gates IC306B (B4), IC306C, IC308B, and IC308D which drives the inhibit bus. In the event that the COMPLETE comparator receives a false indication, perhaps because of insufficient settling time for the reading, treating will resume if the magnetic level rebounds above the COMPLETE level.

IC317D-14 changes state from low to high when the flux density falls below the LOW REJECT limit. This cancels the COMPLETE signal, through IC301D (C7), and it illuminates the LOW REJECT lamp. The process already has been stopped at this time by comparator IC317A because the magnetic level is below the COMPLETE limit.

Charging of the energy-storage bank is also inhibited during the period of the treating gate and of the blanking timer, through IC308A (B5) and IC308D which control the inhibit bus.

Automatic Reset

It is generally desirable to reset the dual-slope integrator automatically each time the flip-flop IC309B is reset, because the treating fixture is emptied at this time. Reset will occur if the RESET jumper (C2) is placed in the AUTO position. The RESET pulse is generated by the reset timer, IC307 (C1), which is started through IC309A each time IC309B is reset.

IC302 (B5) provides for an isolated, external input signal to reset the integrator. For this case, the jumper labeled RESET must be placed in the position marked NON.

Other Control Signals

The COMPLETE signal, which appears as a logic high at IC312D-11 (D3), is carried through Q302 to the comparator board where it is used to discharge harmlessly any charge that may remain on the storage capacitors, so that the first treating pulse of a new cycle will not come as a surprise.

A signal signifying that the integrator is saturated enters the automatic module at Terminal U, and is gated through to the INCOMPLETE lamp on the front panel.

IC316B is a voltage follower used as a buffer between the reference-level-setting potentiometers and the voltmeter.

When the automatic module is not included in the system, some means must be provided for completing the inhibit loop, which is carried through this circuit card. Near Terminal 22 of the edge-connector socket for the automatic module, mounted on the main circuit board, will be found two turret terminals. These are connected to Terminals 21 and 22, and a wire jumper soldered across them will complete the inhibit loop when the automatic module is not used. If the automatic module is installed, but not in use, switch S301, on the front panel, connects the inhibit loop properly.

Options

External Reference Control

An external reference may be applied to J302, Pins 17, 15, and 19 via an optional rear-panel connector. Note — the REM/NORM jumper (CT) must be placed in REM position.

This option is intended for automatic treating of magnets to different levels. Using the external reference will allow rapid, precise charging of the treating levels for a series of magnets such as TWT's.

External Blanking

Isolated remote blanking of the analog gaussmeter, using opto-isolater IC303, NOR gate IC306A, timer IC304 and their associated components; can be accomplished at connector J302, pins 12 and 14.

IEEE-488 INTERCONNECTING BOARD HB-95685

Coupler Module

This option uses a Model 4823 Coupler Module, manufactured by ICS Electronics Corporation, for conversion of BCD data to the format required for the IEEE-488 Bus. The coupler module is described in the ICS instruction book, found in Appendix A, which is shipped with every product using this card. The Model 4823 Coupler is plugged on the Model HB-95685 Interconnecting Board, as shown in Figure10, and it is connected to a charging and treating system through the board. Figure 13 shows the location of the mating connector in the Magnetreater®.

Table 8. Interconnecting Board, Connector P603 — Pin Assignments

Rear Panel Connector, J607 (To Gaussmeter)	J606 (Mates with Interconn.) Card P603)	Signal Description
1	1	1
14	2	4
2	3	10
15	4	40
3	5	100
16	6	400
4	7	1000
17	8	Data Ready
5	9	NC
18	10	NC
6	11	NC
19	12	2
7	13	8
20	14	20
8	15	80
21	16	200
9	17	800
22	18	Minus
10	19	Gnd
23	20	NC
11	21	0.1
24	22	0.2
12	23	0.4
25	24	0.8
13	25	NC
	26	NC

Table 9. Interconnecting Board, Connector P604 — Pin Assignments

488 Address Switch	488 Bus Interface, J605	J604 (Mates Interconn. Card P604)	Signal Des.
X		1	Gnd
X		2	ASW (1)
X		3	LSW(6)
X		4	TSW(7)
X		5	ASW(2)
X		6	SISW(8)
X		7	ASW(5)
X		8	ASW(3)
X		9	ASW(4)
	7	10	NRFD
	17	11	REN
	6	12	DAV
	9	13	IFC
	8	14	NDAC
	5	15	EOI
	11	16	ATN
	10	17	SRQ
	1	18	DI01
	2	19	DI02
	3	20	DI03
	4	21	DI04
	13	22	DI05
	14	23	DI06
	15	24	DI07
	16	25	DI08
	Gnd	26	Gnd
	12		Chassis Gnd
	18-24		

Interconnecting Board

The schematic of the interconnecting board is shown in Figure 20.

At Area (C,D8) the binary-coded decimal data from a digital-indicating gaussmeter, such as the RFL Model 912, received through P603, are protected by resistor-diode networks. Table 8 shows the pin assignments for connector P603.

Plug P604 provides standard IEEE-488 Bus connection, including address switches. All are cable connected to the rear panel. The pin assignments for P604 are listed in Table 9.

Jack P601 (D6) delivers parallel BCD data to the Model HB-95695 Digital-to-Analog Reference Generator, when this module is used in lieu of the dual-slope reference generator in automatic-treating applications. The remaining latched outputs control various relays, or signal drivers.

IC603, Q601, Q602, and Q605 (A4) form a switched, voltage regulator. It is powered from a 20-Vdc, unregulated source, and it provides 5-Vdc power for other circuits on the board. The output voltage is adjusted with R616 (A5).

IC604-607 (C,D6) provide voltage-level shifting from the coupler board, mounted on J601, to the D/A reference generator board which mounts in J603. This quad-voltage level shifter operates at a 5-volt logic level, while the other circuits on the interconnecting board, operate with a logic level of 12 or 15 volts.

IC601 and IC602 (C,D4) invert, level-shift, and sink currents for operating relays and other devices. IC602 operates relays K601, K602, and K603. When K601 is energized, a magnet charger fires; when the Model 990 is used in a combined charging and treating system. Similarly, K602 provides for energizing the charger and K603 controls a programming relay in the magnet charger.

In P603, Pins 21-24 (C,D1), and on the dual slope latch plug-on board on the back of the module, Pins A through H (C,D1) provide for input protection for those applications in which 4½-digit BCD data are required. When 4½-digit BCD data are not used, pull-up resistors R602-R605 are required. The remaining circuits on the plug-on board provide the choice of latching, or not latching, the output signals from the control board to control the fast and slow input channels to the dual-slope control module. Figure 21 shows the schematic of the dual-slope-latch, plug-on board.

DIGITAL-to-ANALOG REFERENCE GENERATOR HB-95695

This digital-to-analog converter is plugged into the Model 990 in the edge-connector socket vacated by the dual-slope reference generator when control of treating pulses is given to the bus controller. Because this controller gives its commands in digital form, the digital-to-analog converter is used to provide the analog reference levels required by the comparator card. A ribbon cable connects parallel BCD signals from connector J603 of the interconnecting card to the D-to-A card.

The D-to-A card, the schematic of which is shown in Figure 22, generates a negative-going reference. The more negative the reference signal, the greater is the amplitude of the treating pulse. The range of the BCD input is from 1999 counts, for minimum treating-pulse amplitude, through zero, to -1999 counts for maximum amplitude of treating pulse.

IC509 (B2) generates a positive-2-volt reference voltage, stabilized by CR511, and IC508 (B3) generates a negative-2-volt reference voltage. IC501 (B4) is a dual SPST semiconductor switch which selects the positive or the negative reference according to the voltage on its two control inputs, Pins 1 and 2. A logic zero at either control input causes the corresponding switch to close (conduct).

IC503 (A-D5) is a digitally controlled electronic potentiometer with digital inputs, received from the interconnecting card, buffered by IC501 and IC502. The output, at Pin 1, is connected to a gain and offset circuit which provides a choice of two different output-voltage ranges for the reference signal to the comparator board. One range is from 12 to -12 volts, the other is from zero to -8 volts.

When the range from 12 to -12 volts is desired, offset current from the 2-volt reference source is removed by omitting either R505 or R506 (D3), and by soldering a 60K resistor across the turret terminals provided at Position R507 (D2) on the circuit board. R507 sets the gain of IC507.

When the output-voltage range of zero to -8 volts is desired, R505 and R506 are included in the circuit, and a 20K resistor is soldered at Position R507.

TABLE OF REPLACEABLE PARTS

Circuit Symbol	Description	RFL Part Number
	Main Frame — Assembly HB-95640	
C1,2,16	Capacitor, electrolytic, 2200µF, -10+50%, 40V Stettner-Trush FB 2T/40, or eq.	H-1007-1172
C3,5	Capacitor, electrolytic, 1000µF, +50-10%, 25V, Siemens B41010-1000/25/8212, or eq.	H-1007-957
C4	Capacitor, electrolytic, 470µF, T50-10%, 40V, Siemens B41010-470/40/8212, or eq.	H-1007-959
C6	Capacitor, ceramic disc, 0.01µF, 20%, 100V, Sprague TG-S10, or eq.	H-1007-1261
C7-11,14,15	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C12,13	Capacitor, paper, oil-filled, 50µF, 600V, Indus. Cond. Corp. 9899 SAR, or eq.	HA-1609
C17	Capacitor, ceramic disc, 0.01µF, 20%, 3000V, Sprague 30GA-S10, or eq.	HA-1007-1442
CR1-4	Diode, silicon, 5A, 400PIV, Semicon, Inc. S-5A4, or eq.	HA-31024
CR5	Diode, Type 1N4001	HA-38876
CR6,7	Diode, silicon, 3A, 1400 PIV, Sarkes Tarzian 3 AF14, or eq.	HA-91319
CR8	Diode, silicon, Type 1N9148/1N4448	H-26482
DS1,3	Lamp, neon, red, Drake 6182-000-323, or eq.	HA-16858
DS2	Lamp, neon, amber, Dialight 249-7841-933, or eq.	HA-14222
DS4-11	Lamp, LED, red, Texas Instruments TIL 220, or eq.	HA-38939
F1,2	Fuse, 1½A, 3AG, 250V Slo-blo, Littlefuse 313 01.5, or eq. (115V operation)	HA-17765
F1,2	Fuse ¾A, 3AG, 250V Slo-blo, Littlefuse 313.750, or eq. (230V operation)	HA-10780
IC1,2	Rectifier, bridge, 100V, 6A, Varo VH148, or eq.	HA-41934
IC3	Linear voltage regulator, National LM-340T-12, or eq.	H-0620-69
IC4	Linear voltage regulator, National LM-3207-12, or eq.	H-0620-121
IC5	Opto-isolator, Litronix IL-CA2-30, or eq.	HA-41084
K1	Relay, DPDT, 12Vdc coil, Struthers-Dunn 425xBX-12V, or eq.	HA-95622
Q1,2	Transistor, silicon, PNP, Motorola MPS-U95, or eq.	HA-47509
Q3,5,6,7,10	Triac, 8A, 600V, RCA T2800M, or eq.	HA-95629
Q4	Transistor, silicon, PNP, Type 2N2907A	HA-37439
Q8,9	Triac, 40A, 600V, G.E. SC265M, or eq.	HA-94116
R1,2	Resistor, wirewound, 50 ohms, 5%, 25W, Ohmite 0200D, or eq.	HA-1100-43
R3,4,7,8,9,10, 11,32	Resistor, fixed, composition, 5%, 0.25W, value on schematic, Allen Bradley CB, or eq.	H-1510-2106
R5	Resistor, metal-film, 330 ohms, 5%, 2W, Corning FP42, or eq.	H-1510-2105
R6	Resistor, metal-film, 470 ohms, 5%, 2W, Corning FP42, or eq.	H-1510-2106
R12	Resistor, wirewound, 800 ohms, 5%, 50W, Memcor FR-50, or eq.	H-1100-547
R13	Resistor, adjustable, wirewound, 2K, 10%, 25W, Ohmite 0377, or eq.	H-1100-97
R14	Resistor, wirewound, 2K, 5%, 25W, Ohmite 0207, or eq.	H-1100-737
R15,16	Resistor, wirewound, adjustable, 10K, 10%, 12W, Ohmite 1040, or eq.	H-1100-228
R17	Resistor, wirewound, 51K, 5%, 12W, Ohmite 3843, or eq.	H-1100-738
R18	Resistor, metal-film, 130K, 5%, 2W, Corning C42, or eq.	H-1510-781
R19	Resistor, metal-film, 15K, 1%, 0.125W, Type RN55D, RFL Spec. HA-38301	H-1510-481
R20	Resistor, metal-film, 1.5 Meg, 2%, 2W, Corning FP42, or eq.	H-1510-2107
R21,22,23	Resistor, variable, wirewound, 10K, 5%, 1W, Bourns 3250W-1-103, or eq.	HA-95625

Circuit Symbol	Description	RFL Part Number
R24,25,26, 29,30	Resistor, variable, composition, 10K, 10%, 2W, Clarostat 53C3-10K-S, or eq.	HA-23316
R27	Resistor, variable, composition, 1 Meg, 10%, 2W, Clarostat, 53C-1Meg-S, or eq.	HA-23835
R28	Resistor, metal-film, 1K, 1%, 0.25W, Type RN1/4, RFL Spec HA-38328	H-0410-1288
R29,30	Not used	
R31	Resistor, wirewound, 2 ohms, 5%, 25W, Ohmite 0200K, or eq.	H-1100-736
S1,10	Switch, toggle DPDT, Cutler-Hammer 7565K5, or eq.	HA-7036
S2	Switch, toggle 3PDT, C&K 7301-W3, or eq.	HA-95638
S3,4,5	Switch, toggle, SPDT, C&K 7103-W3, or eq.	HA-95636
S6	Switch, toggle SPDT, C&K 7101-W3, or eq.	HA-95635
S7,8,9	Switch, pushbutton, SPDT, C&K S121, or eq.	HA-26133
T1	Transformer	HA-95673
T2	Transformer, power, Triad F350XP, or eq.	HA-95664
T3	Transformer	HA-95674
—	Schematic, main frame (Figure 15)	HB-95684
	Comparator Board, Assembly HB-95610	
C101	Capacitor, dipped mica, 0.001 µF, 5%, 100V, Electro Motive DM-19 or eq.	H-1080-395
C102	Capacitor, metallized mylar, 1.0µF, 2%, 100V, Wesco 32MM, or eq.	H-1007-795
C103, 106, 113	Capacitor, ceramic disc, 0.01µF, 20%, 100V, Sprague TG-S10, or eq.	H-1007-1261
C104,111, 116,118	Capacitor, ceramic, 1.0µF, +80-20%, 50V, Sprague 5C023105D850005, or eq.	H-1007-1153
C105,114, 117	Capacitor, dipped mica, 450µF, 2%, 500V, Electro Motive DM-19, or eq.	HA-16631
C107-110, 115	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C112	Capacitor, metallized mylar, 0.1µF, 2%, 200V, Wesco 32MM, or eq.	H-1007-1140
C119	Capacitor, ceramic disc, 0.02µF, +80-20%, 25V, Erie 5835-000Y5U203Z, or eq.	H-1007-754
CR101-106, 108-113	Diode, silicon, Type 1N914B/1N4448	HA-26482
CR7	Linear voltage reference, National LM329BZ, or eq.	H-0620-137
IC101,103	Linear, quad comparator, National LM339N, or eq.	H-0620-119
IC102,104	Linear functional block, National LM555CN, or eq.	H-0620-108
IC105	Quad linear op amp, National LM324N, or eq.	H-0620-116
Q101,107, 111	Transistor, silicon, PNP, Type 2N2907A	HA-37439

Circuit Symbol	Description	RFL Part Number
Q102-105	Transistor, silicon, PNP, Motorola MPS-U95, or eq.	HA-47509
Q106,108, 109,110	Transistor, silicon, NPN, Type 2N2222A	HA-37445
R100-111, 120-134, 135-150, 152,154-158, 164,166-169	Resistor, metal-film, 1%, 0.25W, value on schematic, Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R112-115	Resistor, metal-film, 470 ohms, 5%, 2W, Corning FP42, or eq.	H-1510-2106
R116,117, 118	Resistor, metal-film, 330 ohms, 5%, 2W, Corning FP42, or eq.	H-1510-2105
R119	Resistor, metal-film, 82 ohms, 5%, 2W, Corning FP42, or eq.	H-1510-2104
R151	Resistor, fixed, composition,1 Meg, 5%, 0.25W, Allen Bradley,CB, or eq.	H-1009-798
R153	Resistor, variable, metal-film, 100K, 10%, 0.75W, Helipot 89WHR100K, or eq.	HA-29235
R165	Resistor, fixed, composition, 680K, 5%, 0.25W, Allen Bradley CB, or eq.	H-1009-945
—	Schematic, comparator board (Figure 16)	HB-95614
	Dual-Slope Board, Assembly HB-95620	
C201	Capacitor, metallized mylar, 2.2µF, 2%, 200V, Wesco 32MM, or eq.	H-1007-722
C202,211 217,218	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C203,204 205	Capacitor, dipped mica, 0.00105µF, 2%, 500V, Electro Motive DM-19, or eq.	HA-16209
C206,208,210	Not used	
C207,209, 215	Capacitor, ceramic, 1.0µF, +80-20%, 50V, Sprague 5C023105D8500C5, or eq.	H-1007-1153
C212,214	Capacitor, ceramic disc, 0.01µF, 20%, 100V, Sprague TG-S10, or eq.	H-1007-1261
C213	Capacitor, ceramic, 0.47µF, +80-20%, 50V, Sprague 5C023474D850005, or eq.	H-1007-939
C216	Capacitor, dipped mica, 450pF, 2%, 500V, Electro Motive DM-19, or eq.	HA-16631
CR201,211	Diode, silicon, Type 1N914B/1N4448	HA-26482
CR202-210	Not used	
IC201	Quad, 2-input NAND Schmitt, RCA CD4093BE, or eq.	H-0615-59
IC202,203	Dual analog switch, SPST, Siliconix DG200, or eq.	H-0605-3
IC204	Linear opamp, National LM741CN, or eq.	H-0620-52
IC205,206	Linear opamp, National LF355H, or eq.	H-0620-139
IC207	Quad, 2-input OR gate	H-0615-24
IC208,209	Not used	
IC210	Linear functional block, National LM555CN, or eq.	H-0620-108
Q201	Transistor, silicon, NPN, Type 2N2222A	HA-37445
R201,203, 204,206-213 215-230, 232,235-239	Resistor, metal-film, 1%, 0.25W, value on schematic, Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R202,205, 214,233,234	Not used	
R226	Resistor, fixed, composition, 10 ohms, 5%, 0.25W, Allen Bradley CB, or eq.	H-1009-823
R231	Same as R201, factory-selected value, Standard resistance 300 ohms	H-0410-1238
—	Schematic, Dual-Slope Board (Figure 17)	HB-95624

Circuit Symbol	Description	RFL Part Number
	Automatic Module (Main Board) Assembly HB-95650	
C301,302	Capacitor, tantalum, 4.7µf, 20%, 20V, Kemet, T322B475M020P5, or eq.	H-1007-711
C303,304	Capacitor, ceramic, 1.0µF, +80-20%, 50V, Sprague 5C023105D850005, or eq.	H-1007-1153
C305	Not used	
C306,315	Capacitor, metallized mylar, 0.47µF, 2%, 200V, Wesco 32MM, or eq.	H-1007-1138
C307,311 313,314	Capacitor, ceramic disc, 0.01µF, 20%, 100V, Sprague TG-S10, or eq.	H-1007-1261
308	Capacitor, polystyrene, 0.33µF, 1%, 100V, F-Dyne PST-11.33-100-1, or eq.	H-5115-286
C309	Capacitor, metallized polycarbonate, 0.47µF, 2%, 100V, Wesco 32 MPC, or eq.	H-1007-971
C310	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C312	Capacitor, ceramic disc, 0.01µF, 10%, 500V, Erie 801-000-X5F0-102K, or eq.	H-1007-235
CR301	Linear voltage reference, National LM329BZ, or eq.	H-0620-137
CR302-316	Diode, silicon Type 1N914B/1N4448	HA-26482
IC301,316, 317	Linear opamp, Texas Instruments TL084CN, or eq.	H-0620-151
IC302,303	Opto-isolator, Litronix IL-CA2-30	HA-41084
IC304,307	Linear functional block, National LM555CN, or eq.	H-0620-108
IC305	Dual analog switch SPST, Siliconix DG200BA, or eq.	H-0605-3
IC306	Quad, 2-input, NOR, gate, RCA CD4001BE, or eq.	H-0615-3
IC308	Quad, 2-input OR gate, RCA CD4071BE, or eq.	H-0615-24
IC309	Dual, D-type flip-flop, RCA CD4049AE, or eq.	H-0615-1
IC310	Hex inventer-buffer, RCA CD4049AE, or eq.	H-0615-7
IC311	Quad, 2-input NAND gate, RCA CD4011AE, or eq.	H-0615-5
IC312,313, 315	Quad, 2-input AND gate, RCA CD4081BE, or eq.	H-0615-31
IC314	Transistor array, Texas Instruments ULN2004AN, or eq	H-0720-1
Q301, 303	Transistor, silicon, NPN, Type 2N2222A	HA-37445
R301-312, 314,317, 319-326, 328-333, 335-343	Resistor, metal-film, 1%, 0.25W, value on schematic, Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R313,318	Resistor, variable, metal-film, 10K, 10%, 0.5W, Helipot 68XR10K, or eq.	HA-49997
R327	Resistor, variable, metal-film, 1 Megohm, 20%, 0.75W, Helipot 89WHR1M, or eq.	HA-37494
R334	Resistor, fixed, composition, 2 Megohms, 5%, 0.25W, Allen Bradley CB, or eq.	H-1009-859
RZ301	Resistor network, cermet, 47K, 2%, 1.5W total, Beckman 899-3-R47K, or eq.	HA-46900
—	Schematic, Automatic Module, Main Board (Figure 18)	HB-95654

Circuit Symbol	Description	RFL Part Number
	Control Board, Assembly HB-95656	
C401	Capacitor, ceramic, 1.0µF, +80-20%, 50V, Sprague 5C023105D850005, or eq.	H-1007-1153
C402	Capacitor, ceramic, 0.1µF, GMV, 50V, Kemet C320C104P5U5EA, or eq.	H-1007-1366
C403	Not used	
C404	Capacitor, dipped mica, 100pF, 10%,100V, Electro Motive DM-10, or eq.	H-1080-328
C405	Capacitor, polypropelene, 0.1µF, 2%, 400V, F-Dyne PPA-11-.11-100-Z, or eq.	H-0105-55
C406	Capacitor, mylar, 0.47µF, 2%, 100V, Wesco 32M, or eq.	H-1007-448
C407	Capacitor, polypropelene, 0.22µF, 2%, 100V, F-Dyne PPA-11- 22-100-2, or eq.	H-0105-84
CR401	Diode, zener, 5.1V, 400mW, Type 1N751A	HA-37497
DS401	Display, 7-segment, red, Hewlett-Packard HP5082-7736, or eq.	HA-95621
DS402,403, 404	Display, 7-segment, red, Hewlett-Packard HP5082-7731, or eq.	HA-95619
DS405-406, 407,409	Lamp, LED, red, Texas Instruments TIL220	HA-38939
DS408	Lamp, LED, green, Texas Instruments TIL222	HA-95628
IC401	A/D Converter, 3½ digit, Intersil ICL710CPL, or eq.	H-0625-4
IC402	Not used	
IC403	Linear voltage regulator, 5V, National LM340T-5, or eq.	H-0620-178
R401,403, 404,406, 407,445	Resistor, metal-film, 1%, 0.25W, value on schematic, Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R402	Resistor, variable, metal-film, 1K, 10%, 0.5W, Helipot 68XR1K, or eq.	HA-91952
R408-434, 437-440	Not used	
R435,436, 441,442	Resistor, wirewound, 10K, 5%, 1W, Bourns 3250W1-103, or eq.	HA-95625
S401	Switch, toggle, DPDT, C&K 7201-W3, or eq.	HA-95637
S402	Switch, rotary, 1DCK, 1P/D, 5P, Grayhill 24878-05N, or eq.	HA-95652
—	Schematic Control Board (Figure 19)	HB-95659
	Programming Option Assembly HB-95670-1	
—	Relay 3PDT, 10A, coil 12Vdc, Potter & Brumfield KRP14DC, Type 324, or eq.	HA-26149
—	Wiring diagram, program option	HB-96229
	D/A Reference Generator, Assembly 95695	
C501	Capacitor, dipped mica, 10pF, 5%, 300V, Electro Motive DM-10, or eq.	H-1080-336
C502,505, 507	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C503,504	Capacitor, dipped mica, 91pF, 5%, 500V, Electro Motive DM-15, or eq.	HA-16521
C506	Capacitor, mylar, 1.0µF, 2%, 100V, Wesco 32M, or eq.	H-1007-464
CR501	Diode, Schottky Aertech A25850, or eq.	HA-49489

Circuit Symbol	Description	RFL Part Number
IC501,502	Hex buffer and connector, RCA CD4050BE, or eq.	H-0615-11
IC503	3½-Digit D/A Converter, Analog Devices AD7525Ln, or eq.	H-0615-103
IC504	Hex Schmitt Trigger, Motorola MC14584 CP, or eq.	H-0615-60
IC505,506, 507	Linear opamp, National LF256H, or eq.	H-0620-143
IC508,509	Linear opamp, National LM208H, or eq.	H-0620-146
IC510	Dual analog switch, SPST, Siliconix DG200 BA, or eq.	H-0605-3
IC511	Linear voltage reference, National LM329 BZ, or eq.	H-0620-137
IC512	Linear voltage regulator, National LM340T-15, or eq.	H-0620-74
Q501	Transistor, silicon, NPN, Type 2N2222A	HA-37445
R501,504, 506-508, 510-513, 515-518	Resistor, metal-film, 1%, 0.25W, value on schematic Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R502,503	Resistor, metal-film, variable, 25K, 10%, 0.75W, Helipot 89WHR25K, or eq.	HA-29211
R505,509	Resistor, metal-film, variable, 1K, 1%, 0.75W, TRW 980-20-1K, or eq.	HA-38542
R514	Resistor, metal-film variable, 50K, 10%, 0.75W, Helipot, 89WHR50K, or eq.	HA-25072
R518	Resistor, fixed, composition, 22K, 5%, 0.5W, Allen Bradley EB, or eq.	H-1009-518
RZ501,502	Resistance network, cermet, 47K, 2%, 1.1W total, CTS 750-81-R47K, or eq.	HA-47880
RZ503,504	Resistance network, cermet, 10K, 2%, 1.5W total, Helipot 898-3-R10K, or eq.	HA-27371
—	Schematic, D/A Reference Generator (Figure 22)	HB-95699

IEE-488 Interconnecting Board, Assembly HB-95685

C601-614, 621, 625-628	Capacitor, ceramic disc, 0.02µF, +80-20%, 25V, Erie 5385-000Y5U203Z, or eq.	H-1007-754
C615,616, 619	Capacitor, electrolytic, 1000µF, +50-10%, 25V, Siemens B 41010, or eq.	H-1007-957
C617,622, 630,633	Capacitor, ceramic disc, 0.1µF, 20%, 100V, Sprague TG-P10, or eq.	H-1007-289
C618	Capacitor, ceramic, 1 µfd, 80%-20%, 50V, Sprague 263725U105-2050B, or eq.	H-1007-1153
C620	Capacitor, dipped mica, 3300 pF, 2%, 500V, Electro Motive DM-29, 29, or eq.	H-16232
C623-624, 634	Capacitor, ceramic, 1.0µF, +80-20%, 50V, Sprague 50023105D850005, or eq.	H-1007-1153
C629,632, 635,636	Capacitor, ceramic disc, 0.01µF, 20%, 100V, Sprague TG-S10, or eq.	H-1007-1261
C631	Capacitor, dipped mica, 0.01 µF, 2%, 500V, Electro Motive DM-19, or eq.	H-1080-286
C637	Capacitor, tantalum, 15uF, 20%, 35V, Sprague, 196D156X0035PEX, or eq.	H-1007-539
CR601	Rectifier, 2A, 400V, G.E. A114D, or eq.	HA-47659
CR602,603, 607-619	Diode, silicon, Type 1N914B/1N4448	HA-26482
CR604-606	Diode, Type 1N4001	HA-38876

Circuit Symbol	Description	RFL Part Number
CR620	Diode, zener, 5.6V, 5%, 1W, Type 1N752A	HA-38037
CRZ601,602	Diode array, Texas Instruments TID125, or eq.	HA-45484
F601	Fuse, cartridge, 1A, 250V, Type 3AG, Littlefuse 312001, or eq.	HA-3736
IC601,602	Transistor array, Sprague ULN2013A, or eq.	H-0720-5
IC603	Universal switching regulator, Fairchild UA78S40PC, or eq.	H-0620-181
IC604-607	Quad, voltage-level shifter, RCA CD40109BE, or eq.	H-0615-80
IC608	Linear voltage regulator, National LM340T-15, or eq.	H-0620-74
IC609,612	Hex Schmitt Trigger, Motorola MC1458CP, or eq.	H-0615-60
IC610	Quad, 2-input, NAND Schmitt trigger, RCA CD4093BE, or eq.	H-0615-59
IC611	Triple, 3-input NAND gate, RCA CD4023BE, or eq.	H-0615-8
K601,602, 603	Relay, DPDT, 12Vdc coil, 320 ohms, Potter & Brumfield R40-E1-Y2-V320, 12Vdc, or eq.	HA-29591
L601	Choke, ferrite, 100uH, 10%, 2A, Caddell-Burns 6310-8, or eq.	HA-41074
Q601	Transistor, PNP, silicon, Texas Instruments TIP34C, or eq.	HA-39483
Q602	Transistor, silicon, PNP, Type 2N2907A	HA-37439
Q603,604	Transistor, silicon, PNP, Motorola MPS-U95, or eq.	HA-47509
Q605	Rectifier, silicon, 200V, G.E. C106B1, or eq.	HA-26136
R601-605, 611,614 615,617, 618,620, 625-631, 633-640, 642,643, 646-649, 652, 655-659	Resistor, metal-film, 1%, 0.25W, value on schematic Type RN 1/4, RFL Spec HA-38328	H-0410-(XXX)
R606-610, 612,613, 624, 632,641	Resistor, fixed, composition, 22 ohms, 5%, 0.25W, Allen Bradley EB, or eq.	H-1009-239
R616	Resistor, variable, metal-film, 20K, 10%, 0.75W, Helipot 89PR20K, or eq.	HA-39504
R619	Resistor, wirewound, 0.1 ohm, 5%, 3W, LTV Electrosystems RW69V10, or eq.	H-1100-606
R621-623	Resistor, fixed, composition, 510 ohms, 5%, 1W, Allen Bradley GB, or eq.	H-1009-643
R644,650, 651	Resistor, fixed, composition, 5%, 0.25W, value on schematic, Allen Bradley CB, or eq.	H-1009-798
R645	Not used	
RZ601-604	Resistor network, cermet, 2.2K, 1%, 1.5W total, CTS 760-3-2-2.2K, or eq.	HA-38995
RZ605	Resistor network, cermet, 10K, 2%, 1.5W total, Helipot 898-3-R10K, or eq.	HA-27371
—	Schematic, Interconnecting Board (Figure 20)	HB-95684

P/O FRONT PANEL

SWITCH & INDICATOR MODULE

P/O RESISTOR PANEL

AUTOMATIC MODULE DISPLAY SERIES 400

-1.888

J1 AUTOMATIC MODULE SERIES 300

J2 DUAL SLOPE MODULE SERIES 200 / D-A REF GEN.-488 SERIES 500

J3 COMPARATOR MODULE SERIES 100

J4 INTERCONNECTING MODULE-(488) SERIES 600

*- INDICATES OPTIONAL EQUIPMENT

790A White TB-B4 Blk TB B10

Figure 15. Schematic of main frame, Series 900

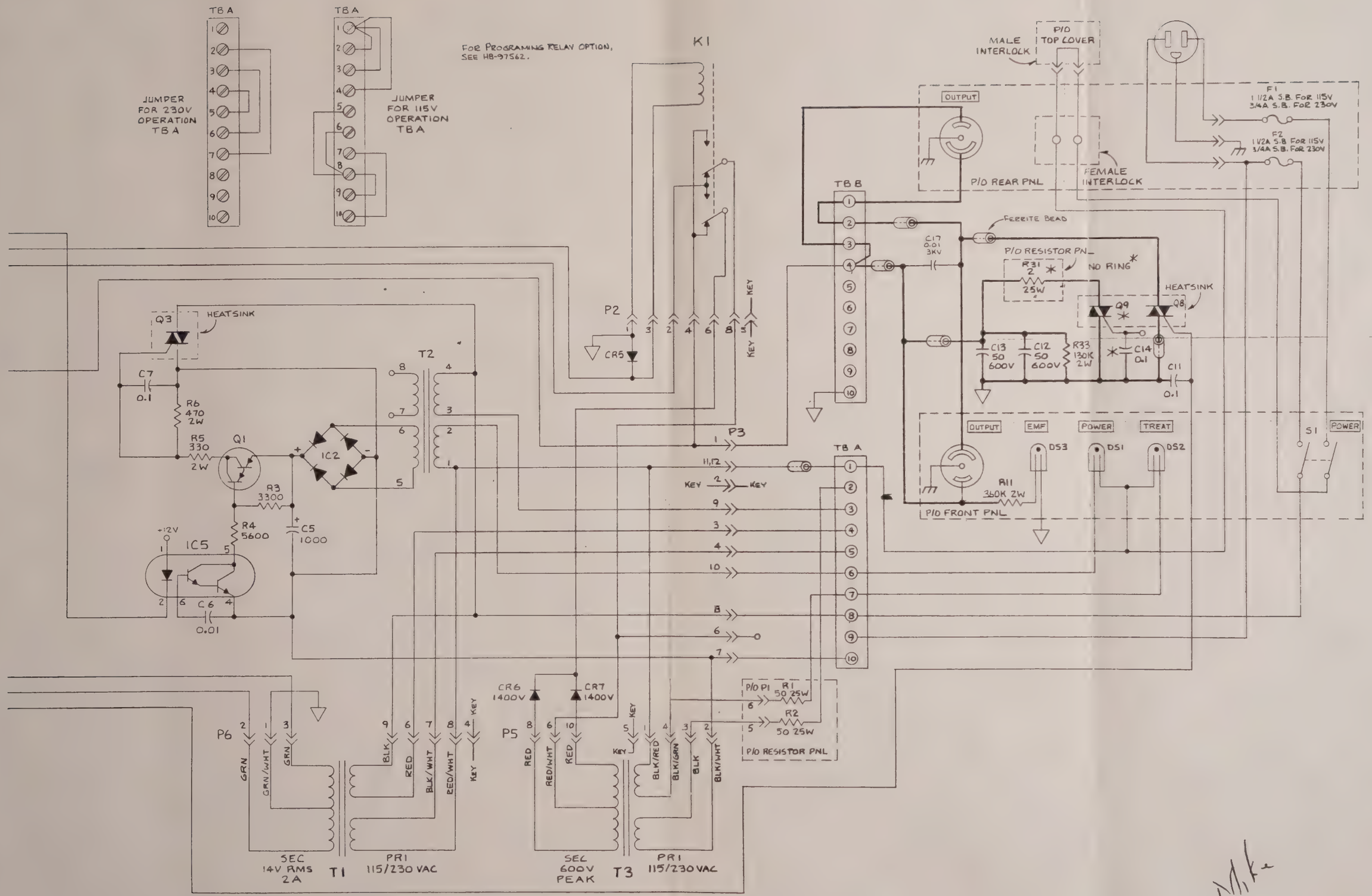


Figure 15. Schematic of main frame, Series 990

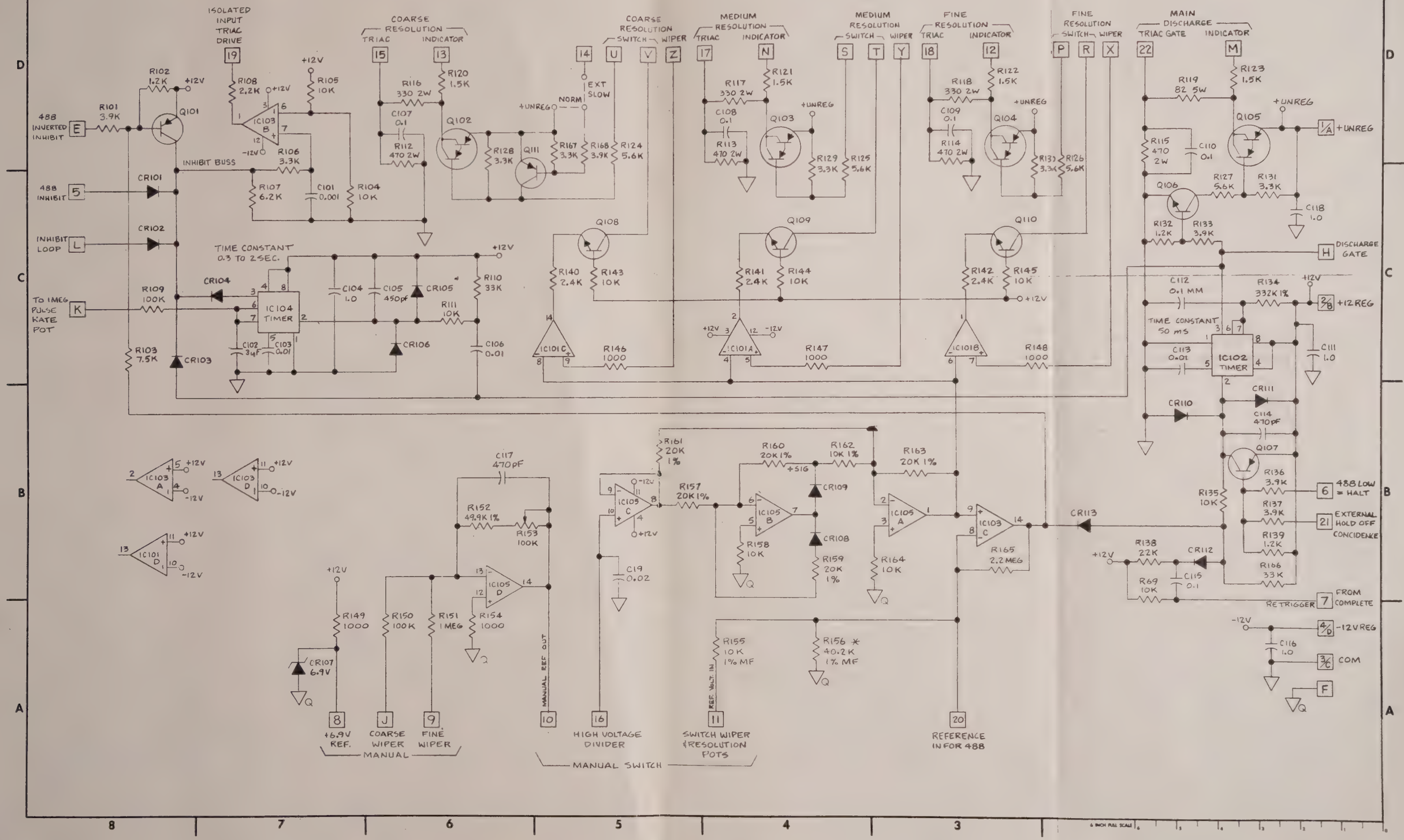


Figure 16. Schematic of Comparator Board

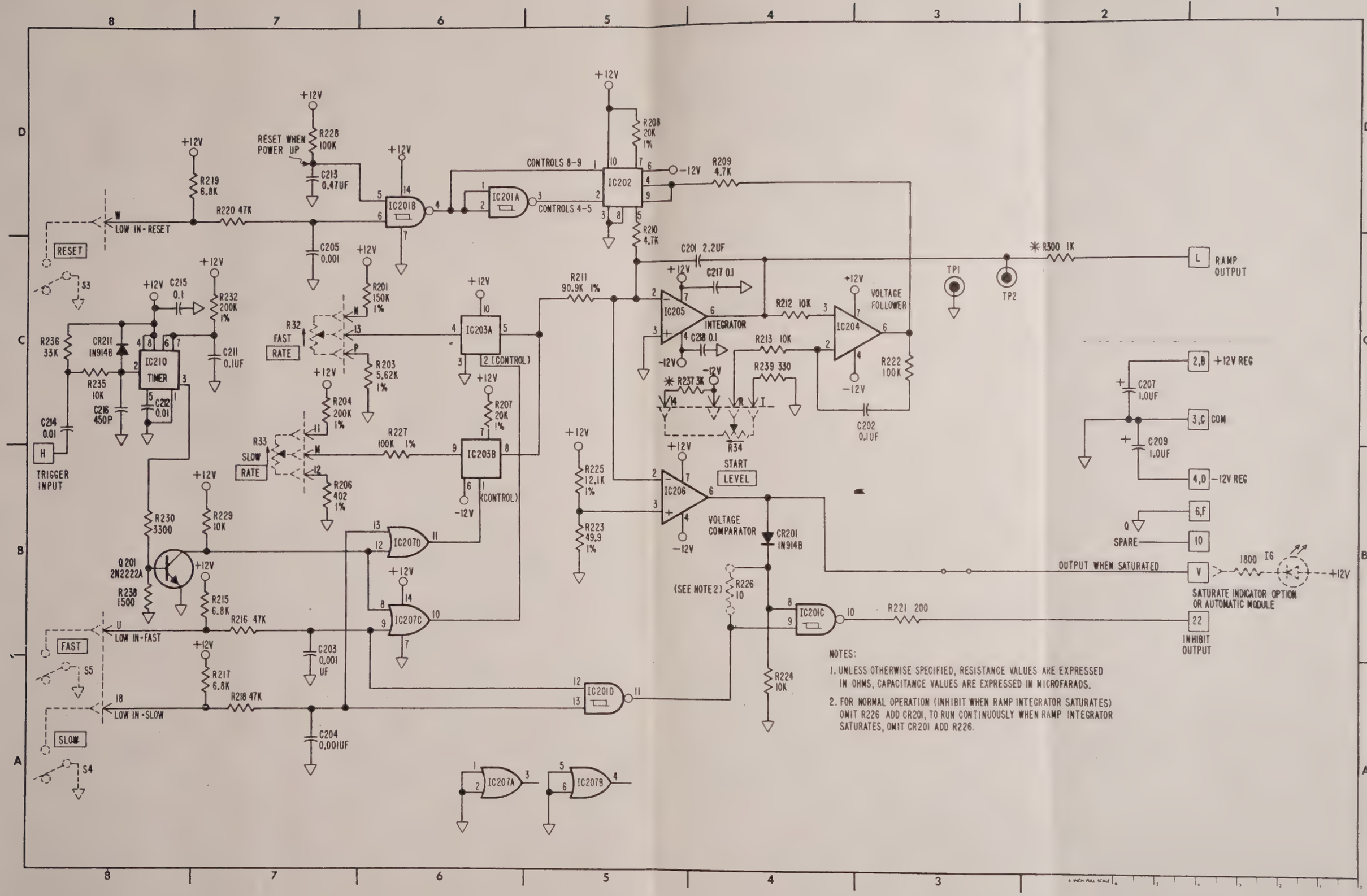


Figure 17. Schematic of Dual Slope Control Board

* FOR USE WITH MODEL 912 & 916 (5V INPUT) OMIT R306 FOR UNITY GAIN FROM 2.667.

TO CONTROL MODULE SCHEMATIC 95659

ANALOG GUASS METER ±(1→3)V

Z ≤16 IN

OPTION REAR PANEL P/O J302

TO CONTROL MODULE SCHEMATIC P/O J401 P/O J301

CABLE ASSY 95655

20V UNREG

INHIBIT LOOP

BLANKING

REFERENCE

REM / NORM

GAIN CW R313 10K

AUTO RESET / NORM

R332 5.6K, R335 3.3K, Q301

FAST TRIAC TURN OFF (15)

RUN SLOW OUT (18)

RUN FAST OUT (17)

DUAL SLOPE INTEGRATOR SATURATION INPUT (U)

GATE RETRIGGER OUT WHEN COMPLETE (7)

DUAL SLOPE IN OR OUT RESET BUS (19) RESET

COMPLETE OUT (Y)

TREAT GATE IN (H)

OPTION (REAR PANEL) ISOLATOR SET

TO CONTROL MODULE SCHEMATIC 95659 — MIN.SAT. REJ. / TREAT / INCOMP. / COMP. / LOW REJ.

NOTE:
ALL DIODES ARE IN914B UNLESS OTHERWISE SPECIFIED.

Figure 18. Schematic of Automatic Module (Main

DS401 -1
DS402 8
DS403 8
DS404 8
+5V
R401 150
IC401
R404 47K
R406 100K
C407 0.22 uf
C406 0.47 uf
C405 0.1uf
C404 100 PF
C401 1uf
CR401 5.1V
R407 1.6K
C402 0.1uf
IC403 +5 REG
NOMINAL 1000±0.1mV TO "Q" GND
TP401
R402 1K TRIM FULL SCALE (MAY BE ADJUSTED FOR SCALING)
R403 24K
S402
MAG LEVEL
LOW REJECT
COMPLETE
SLOW DOWN
MIN. SAT.
SLOW DOWN R441 10K
COMPLETE R436 10K
LOW REJ. R435 10K
MIN. SAT. R442 10K
R445 4.7K
+12V
S401
AUTOMATIC
MANUAL RAMP
DS405 MIN SAT REJECT
DS406 TREATING
DS407 INCOMPLETE
DS408 COMPLETE
DS409 LOW REJECT
(SPARE)
(SPARE)
-12V
SIGNAL IN
(SPARE)
OUT
IN
(REFERENCE) IN
OUT
OUT
OUT
OUT
SET
AUTO INHIBIT
INHIBIT IN (D.S.)
INHIBIT OUT
IN
CABLE ASS'Y 95655
TO AUTOMATIC MODULE (SCHEMATIC #95654) J 301

Figure 19. Schematic of voltmeter section of

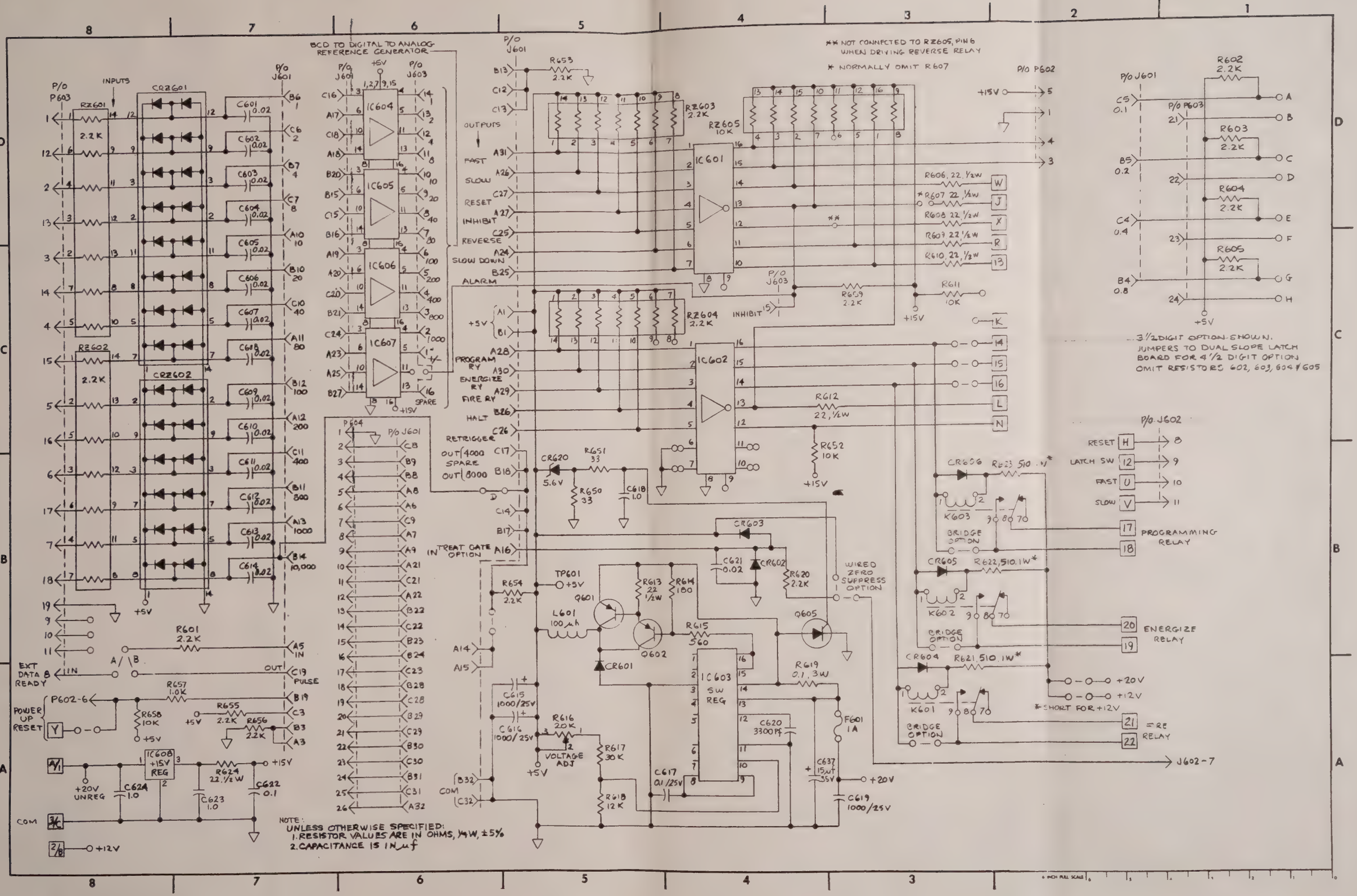


Figure 20. Schematic of Interconnecting Board

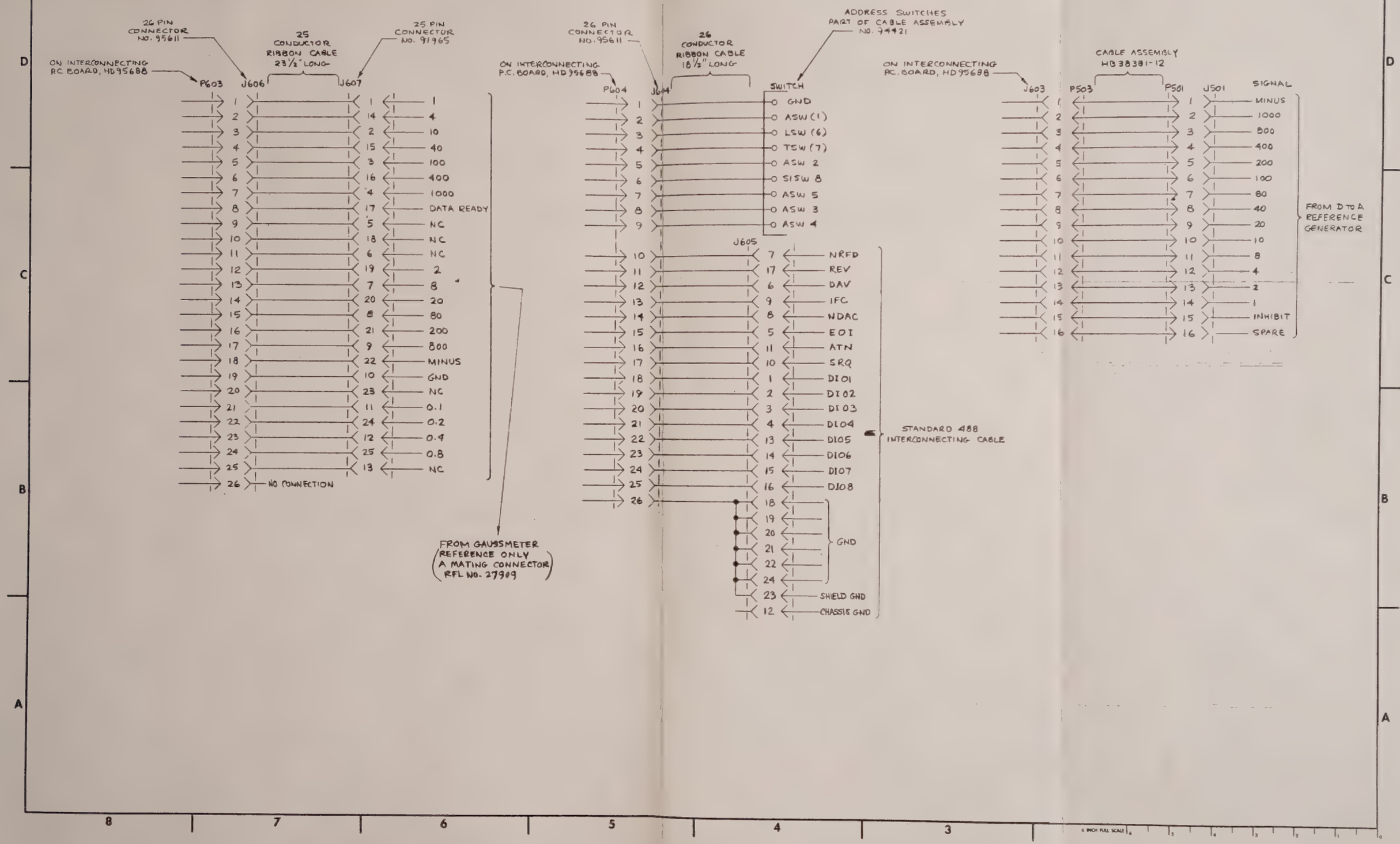


Figure 20. Schematic of Interconnecting Board

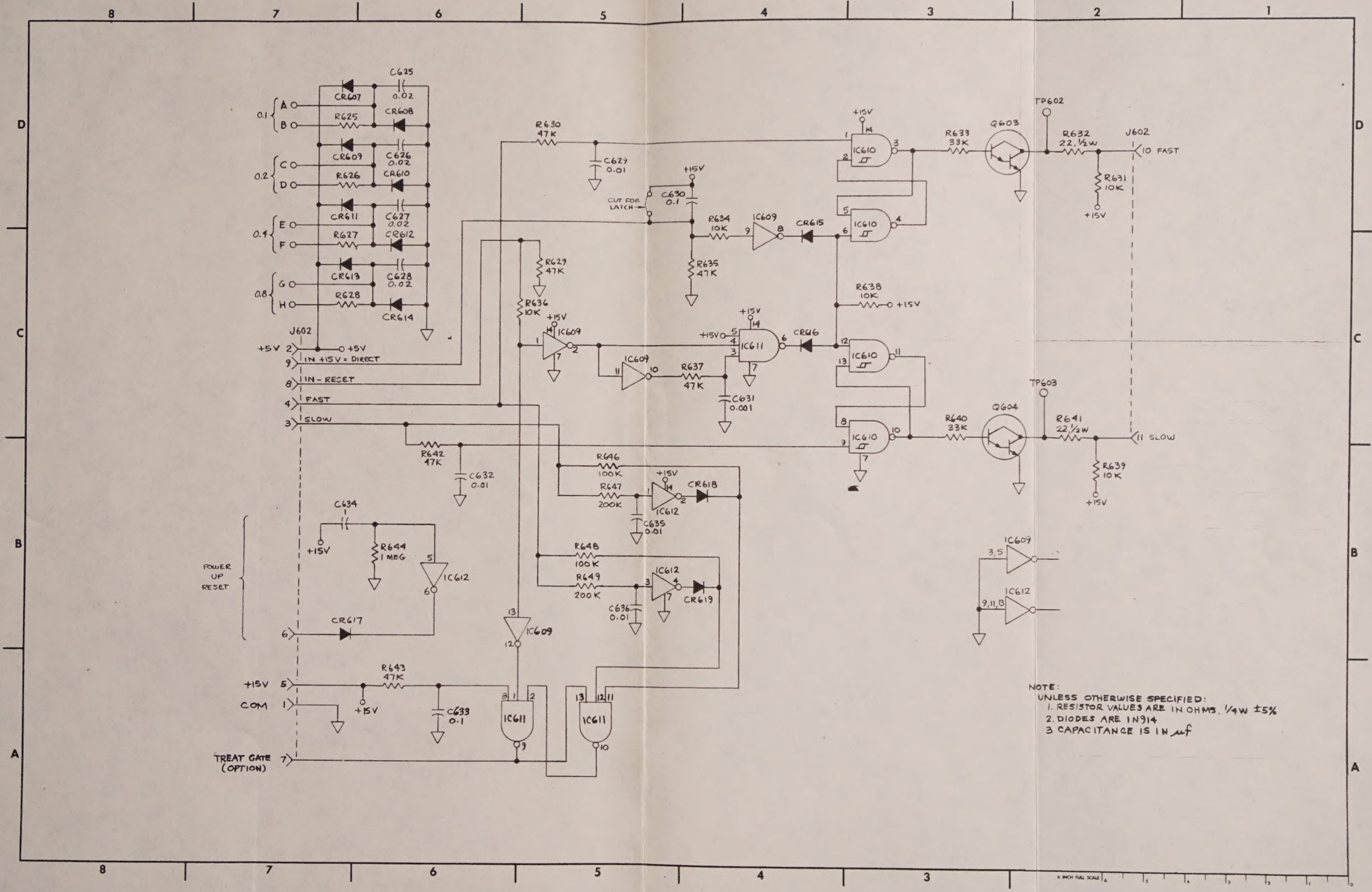


Figure 21. Schematic of Dual-Slope Latch Board

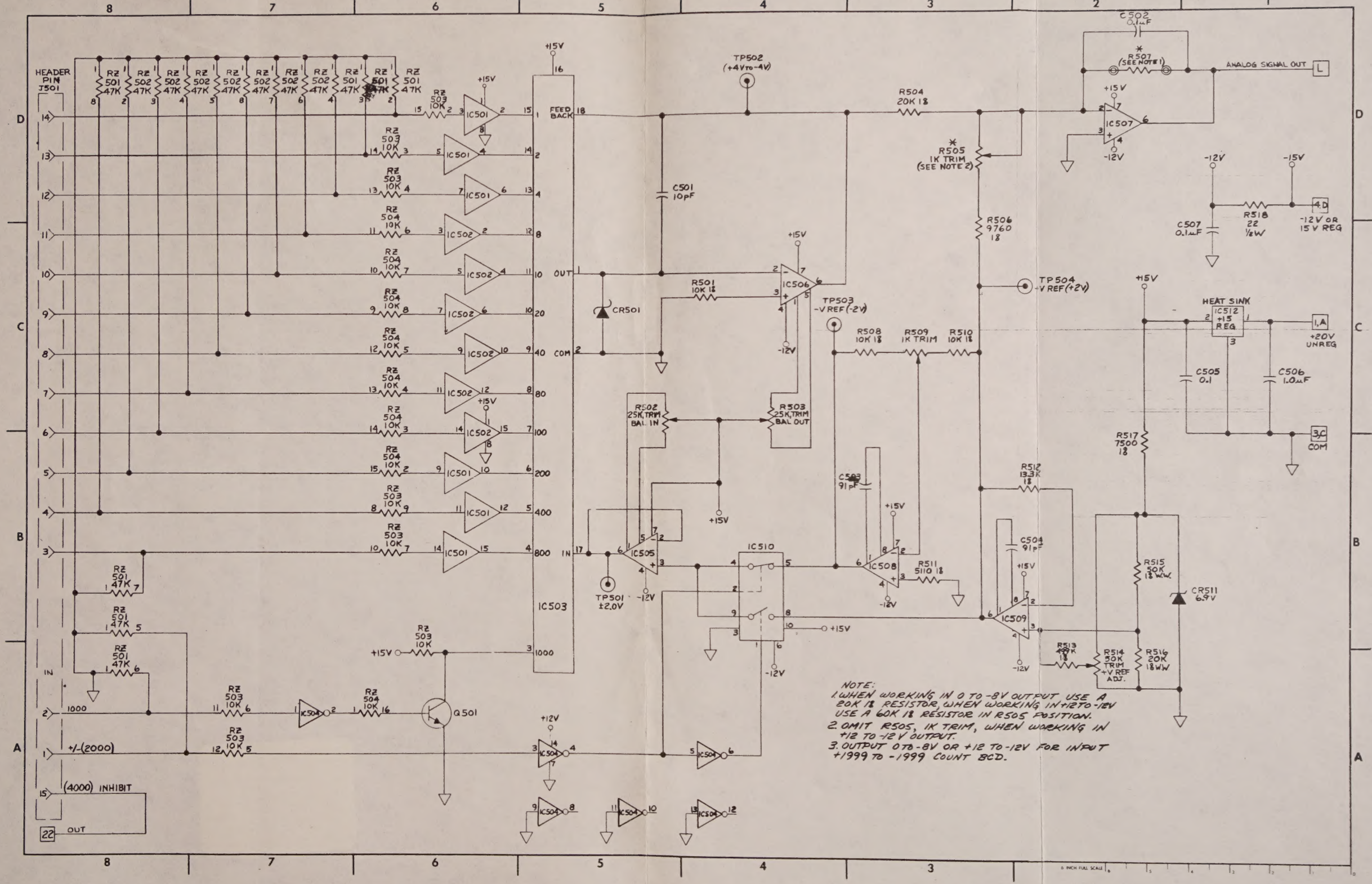


Figure 22. Schematic of D-to-A Reference-Voltage

MP MASTER
MA29129